A Year of Gold, this 1939. In it cyanidation, in its commercial application, celebrates its Golden Anniversary. And though some industries may suffer from insufficient business, the gold miner goes merrily on to bigger and better things, with seemingly no end in sight. The resurvey of the world and its mineral deposits on the basis of $35 gold continues. Miners of base metals carrying gold gain likewise. Many a net profit of the last five years would have been a net loss had it not been for the increase in the price of gold, and, incidentally, of domestic silver.

▼

Current milling practice at Wright-Hargreaves gold mine, at Kirkland Lake, Ont., and its development to its present status will be discussed in an early issue by Malcolm Black, superintendent of the mill. A milling cost of $1.159 per ton was given in the company's last annual report, with the recovery well over 96 per cent.

▼

A Mural entitled "The World of Steel," painted by Clara Fargo Thomas for the United States Steel Corporation, was recently exhibited in the gallery of La Maison Française, in Rockefeller Center, New York City. Done on panels of Macassar ebony, 86 by 11 ft. in size, it strikingly presents the artist's conception of the highlights of steel production and utilization. It will be hung in the Corporation's pavilion at the 1939 New York World's Fair.

▼

Conditions on the Witwatersrand in respect to names of mines and mining companies worsen rapidly, and something should be done about it. Once the reader had nothing more difficult than Luipaards Vlei and Geldenhuis to contend with. Now he must risk choking over stranglers such as Blyvoruitzicht and Vogelstruisbult, with the future very dark as the outlook for new mines grows steadily brighter.

H. C. PARMELEE
Editorial Director

Engineering and Mining Journal

A. W. FISHER
Manager

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H. W. CLARKE
Vice-President

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Back to the farm for a new market for steel went Tennessee Coal, Iron & Railroad Company on Nov. 21, when it started shipping 12 units of prefabricated metal farm buildings to sites selected by Farm Security Administration. Each unit takes 12½ tons of steel, comprises dwelling, barn, chicken house, outdoor pantry, and sanitary privy. These units will be available in several designs. Among steel's advantages are: decreased fire hazard, less waste in construction, possibility of precise machine forming, with low labor costs and moisture-proofness. Steel also can readily be fabricated in convenient large sections.

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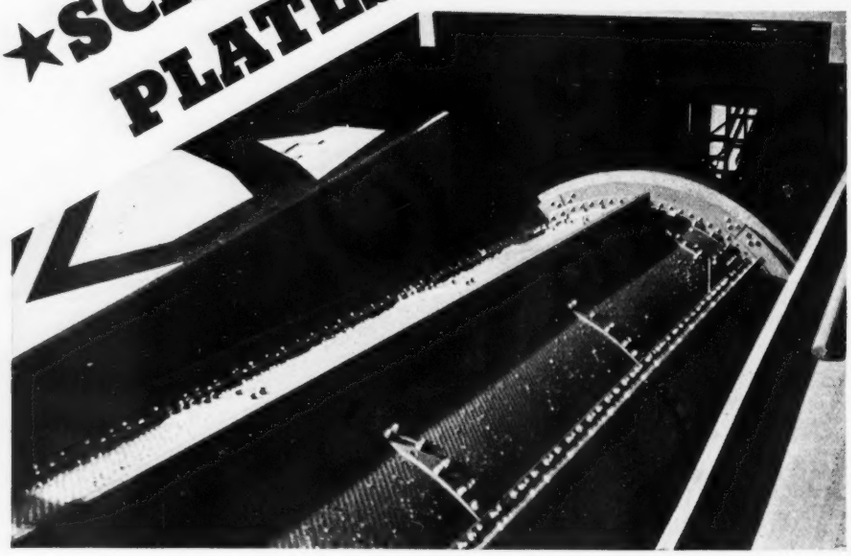
★SCREEN PLATES *by Yuba for* LOWER COST YARDAGE



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San Francisco: J. B. HUTTL, Assistant Editor; G. J. YOUNG, Consultant
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Volume 140 Number 1

JANUARY 1939

Minerals and National Defense

UNDER the head of unfinished business the 76th Congress should unquestionably resume consideration of a bill "to provide for the common defense by acquiring stocks of strategic and critical raw materials, concentrates, and alloys." A bill to that effect was introduced last year by Senator Thomas, of Utah, but Congress took no action. Meantime, as a result of belligerent and uncompromising attitudes on the part of some other nations, the spotlight is focussed anew on our own resources for national defense. The problem, briefly stated in the Thomas bill, is "to decrease and prevent wherever possible a dangerous and costly dependence of the United States upon foreign nations for supplies of these commodities in times of national emergency."

With respect to minerals and metals, the story is an old one. The international control of these commodities has been studied intensively for twenty years, largely as the result of the hasty competitive scramble to procure them during the World War. Consequently, those charged with preparedness for national defense know concretely what is lacking in our economy, and they properly urge remedial measures. Minerals and metals rank high in the list of strategic materials, and the Government should proceed forthwith to provide reserves of such commodities as tin, antimony, manganese, chromium, mercury, and others.

Quite as important as the commodities themselves is the grade or quality of the materials acquired. Obviously, the specifications for military stocks should be no less rigid than those now established by industrial users. Reserve supplies should be amenable to existing industrial processes, ready for immediate use without beneficiation or other intermediate treatment. It would be folly to stock substandard materials.

Another important aspect is the future control and disposition of mineral and metal stocks that may be acquired by the Government for national defense. The Thomas bill contained a controversial clause on this subject. Quite properly it conferred on the President sole power to determine the use of these commodities in time of war. But it also gave him discretion and power to order their use to meet a domestic industrial or economic emergency. We share with many others the feeling that the alternative clause unwisely lodges in the President future political control over substantial stocks of commodities that are important to private industry. Such intent is, of course, denied; but potentially it is there, and none can foresee how it might be used.

Finally, the Thomas bill provided for continuing studies and investigations by the Bureau of Mines and the Geological Survey to determine and develop domestic sources of supply of metals and minerals in which the United States is deficient. This is the part of prudence in national development. New mineral deposits may be discovered and known ones can be developed by improved technology. Equally important is the investigation of substitutes, and keeping abreast of the vast amount of industrial research that is constantly yielding new synthetics with properties equal or superior to those of natural products.

The entire program merits the support of the mineral industries. It can be urged upon Congress unselfishly for national welfare. Compared with other forms of insurance it is relatively inexpensive, and it provides tangible assets of permanent character. With full knowledge and information available for intelligent legislation, the stage is set for action by Congress.

Mining Exhibit at San Francisco Fair

NEWS from the Golden Gate International Exposition which will open shortly in San Francisco indicates that work is proceeding satisfactorily on the erection of "Treasure Mountain" in the Hall of the Mineral Empire. This project, it will be recalled, is sponsored by Mining Exhibits, Inc., an organization of mining men in the Western States created for the purpose of insuring adequate representation and

participation of the mineral industries in the great exposition. All of which is eminently fitting and proper, considering the transcendent importance of mining to the West, and its contribution to the development of the United States.

We shall not dull the keen edge of expectation of the visitor to San Francisco by describing Treasure Mountain and the Hall of the Mineral Empire. Suffice it to say that Treasure Mountain is a substantial reproduction of a rugged mountain range, on the surface and in the interior of which mining operations will be reproduced with a high degree of fidelity and realism. This will be supplemented with murals and dioramas typical of mining activities, and the geography of the industry will be dramatically portrayed. Although the exhibit is designed to be instructive and educational to the layman, it will arouse a sense of pride in the experienced mining man.

But what appeals most to us is the avowed purpose of the sponsors in planning the nature and scope of the exhibit. It is no haphazard aggregation of things relating to mining. The central theme is "Public Relations for the Mining Industry"—something long needed and much neglected. The public ought to have more than a romantic idea of mining. It ought to have an intelligent comprehension of the mineral industry, its economic importance to the nation and the incidence of its products on the welfare of the individual. And yet the public has had no opportunity to acquire such information. Now the lack is to be remedied. In addition to seeing the interesting processes of mining, the public visiting the San Francisco fair will get a clear idea of the mineral industry as an employer, as a tax payer, as a producer of wealth, as a consumer of power and supplies, as a customer of the railroads, as a great and important factor in the nation's economy. As individuals the public will sense the importance in daily life of the products of the mines, and how they contribute to human comfort in shelter, transportation, power, light, and a thousand conveniences that raise the standard of living.

So what? Well, the public that gets that comprehension of the mineral industry will be its sympathetic friend and supporter instead of its skeptical disinterested observer. And the time comes to industries as well as to people when friends are needed. The establishment of good public relations is a long and tedious process which, for the mining industry, should be greatly accelerated by the exhibit at San Francisco's exposition.

Louisiana Saves the Goose

SPEAKING, as we were in the preceding editorial, of the value of having the public informed about the mining industry, we are forcibly reminded of a concrete example in the State of Louisiana. Sulphur is an important mineral product of that State, and the industry is a substantial tax payer. Forgetting the fable of the goose and the golden eggs, Louisiana in 1936 raised the severance tax on sulphur production from 60c to $2 per long ton. The immediate result was curtailment of production, loss of revenue to the State, and abandonment of a $300,000 construction project by the Freeport Sulphur Company. Evidently it was high time to try to revive the goose. Through the efforts of civic, business, and labor groups the matter was taken up by the State Board of Commerce and Industry and later by the Legislature. The latter reduced the severance tax to $1.03 per ton, and the industry cooperated by waiving its constitutional exemption on sulphur in the ground. But the people of Louisiana still had to voice their sentiments, which they did at the recent election by overwhelmingly endorsing the reduction of the severance tax.

Mining men can take courage from this evidence of a new *entente cordiale* between government and industry. The keynote of the undertaking was realistic cooperation based on a clear understanding of the fact that excessive taxation can result in a reduction of revenue through lower industrial activity. Those who believe that punitive taxation can be eliminated and business recovery aided by united action of civic and business groups will find cheering support in the Louisiana incident.

HISTORICAL SUMMARY: ENGINEERING AND MINING JOURNAL was founded in 1866 as the *American Journal of Mining*, the title being changed in 1869. Publications with which *Engineering and Mining Journal* has been consolidated comprise: *Coal and Iron Record* (1875); *The Mining Review* (1877); *The Polytechnic Review* (1879); *Mining and Metallurgy* (1902); *The Mining Magazine* (1906); *Mining and Engineering World* (1917); *Mining and Scientific Press* (1922); *Engineering and Mining World* (1932). All rights to the foregoing titles of consolidated publications are reserved by the publisher. . . . . THE FOLLOWING have served as editors in chief of *Engineering and Mining Journal* and its predecessor publications: G. F. Dawson (1866–67); R. W. Raymond (1867–74); R. W. Raymond and R. P. Rothwell (1874–89); R. P. Rothwell (1890–1901); D. T. Day (1901–02); T. A. Rickard (1903–05); W. R. Ingalls (1905–19); J. E. Spurr (1919–27); A. W. Allen (1927–33); H. C. Parmelee (1933—) . . . . THE EDITORIAL STAFF of *Engineering and Mining Journal* comprises: H. C. Parmelee, editor; A. H. Hubbell, associate editor; H. C. Chellson, W. N. P. Reed, J. B. Huttl, assistant editors; H. H. Wanders, market editor; G. J. Young, consulting editor.

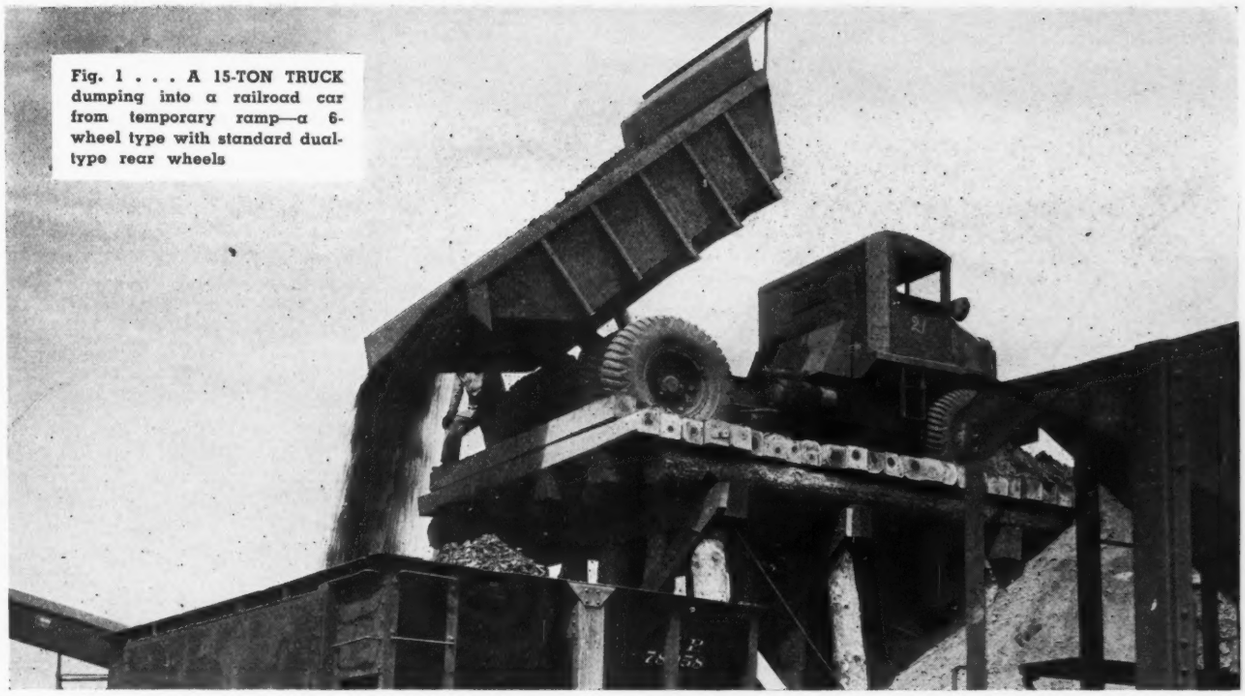


Fig. 1 . . . A 15-TON TRUCK dumping into a railroad car from temporary ramp—a 6-wheel type with standard dual-type rear wheels

Truck Haulage
On the Mesabi and Cuyuna Ranges

The past two years have witnessed the development of specially designed heavy-duty units for open-pit service

R. W. Whitney
Butler Brothers
Cooley, Minn.

Grover J. Holt
Butler Brothers
St. Paul, Minn.

THE HISTORY of open-pit transportation on the Mesabi range has been a gradually changing picture, as brought out in *Engineering and Mining Journal* of October, 1938; whereas, the development of truck haulage covers only a recent and short period. Prior to 1937, small trucks of standard road type equipped with dump bodies had been used in the Dale mine and other properties, but 1937 saw the first large, specially designed, heavy-duty trucks go into operation at Butler Brothers' Louise mine, on the Cuyuna range. During the same year, eight trucks were placed in stripping service at the Mesabi operations of the same company, and in 1938 eleven trucks were used in ore haulage. In both of these operations, the ore was delivered from the pit bottom to cars on the surface by truck. In 1937, four large 20-ton trucks were also used in the Spruce open pit of the Oliver Iron Mining Company on the Mesabi range, feeding a conveyor belt (see *Engineering and Mining Journal*, October, 1938).

Even though truck transportation is in its infancy on the Minnesota ranges, two years of service have proved the merit of this type of equipment for iron-mining service. Experience has demonstrated that only a specially designed truck, built for the heavy service and abuse incidental to this type of work, will survive. *Any revamped highway model will not stand up.*

Several types of trucks of 15-ton capacity have been tested, all of which fall into two classes. First, the six-wheel type having standard dual-type rear wheels, Figs. 1 and 5, and, secondly, the ten-wheel type, having two sets of dual rear wheels (see Fig. 2). Advantages of the ten-wheel type over the six-wheel are few, the main advantage being a more widely distributed load over the roadbed. It has been found, however, that it is easily possible to build a road ample to accommodate the heavier loading per tire on the six-wheel type, which nullifies this advantage.

The advantages of the six-wheel type of truck lie in the ability to negotiate sharper curves, greater tire economy, saving in time of servicing, and lower maintenance cost. Servicing of the truck unit is extremely important and the time required to service a six-wheel truck is about a half hour, as against almost double this time for the ten-wheel unit.

Gasoline- and diesel-engine-driven units have been tested, with all the advantages found to be on the side of the diesel drive. Fuel economy is decidedly in favor of the diesel unit, which consumes generally under 3 gal. of fuel oil per hour on the average operation, as against about 5¼ gal. of gasoline per hour for the gasoline-equipped unit, on the same job. One disadvantage of the diesel drive lies in the smoke produced, which is a serious handicap where the exhaust is discharging under the truck, especially in backing up to dump at night. This, however, is overcome by having the exhaust discharge over the cab, where the smoke is dissipated (see location of

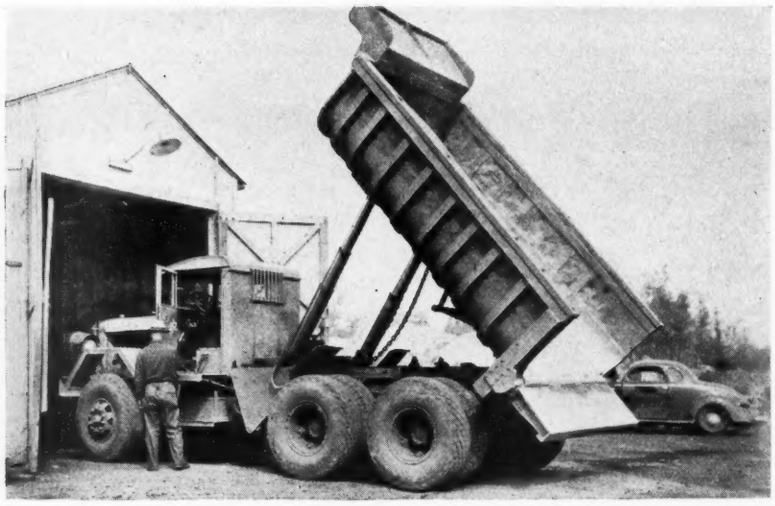


Fig. 2 . . . CLOSE-UP of a 15-ton truck of the 10-wheel type, with body in dumped position. There are two sets of dual rear wheels. Note the field garage and the cab shield

Fig. 3 . . . LOADING STRIPPING into 15-ton trucks with a 4-cu.yd. shovel. Note the elevated exhaust pipe on the trucks and the side boards. The latter are removed for ore service

the exhaust pipe on trucks in Fig. 3).

All diesel units are equipped with tachometers registering engine speed, rather than speedometers. This serves as a check on the driver to make sure that he does not race the engine beyond the safe limit. Overspeed is ruinous to a diesel unit. The tachometer has a locking maximum indicator which can be set back only by the foreman at the end of the shift.

The diesel engines used are Cummins 150-hp. units. These engines will operate for about 3,000 hours without overhauling. This is comparable to about 90,000 miles of service in a road truck, due to the slow speed of travel on stiff grades in pit service. An overhaul job involves the replacement of piston liners and piston rings, as well as reconditioning of other parts.

The diesel unit used in these trucks has been found easy to start even in sub-zero weather.

In open-pit work the life of tires can hardly be based on mileage; consequently the life of a tire is set up on the basis of 4,000 hours of service, equivalent roughly to from 16,000 to 20,000 miles of highway service. Close inspection of tires and immediate care of cuts or bruises is important to tire life.

Three types of bodies have been used, with facilities for dumping on one side, both sides, or rear dump respectively. The most satisfactory type

Fig. 4 . . . IN THE LOUISE PIT (on the Cuyuna range), showing 15-ton trucks at work. The old railroad grade with four switchbacks is still visible. The total railroad haul was 8,500 ft. (averaging 2.6 per cent out of the pit), compared with 3,185 ft. for the truck haul (with a 10 per cent grade out of the pit)

for ore and stripping service has been found to be the rear-dump type with a down-folding tailgate which acts as a chute for the material. (See Fig. 2. Note also the cab shield.) All bodies are of the hydraulic-dump type controlled from the cab.

The life of a truck is estimated at 10,000 hours, although it is possible that some trucks will exceed this with replacements and proper care.

During the earlier period of use of these large units, it was thought that a shovel carrying a dipper of from 1½- to 2- cu.yd. capacity would be more desirable than a shovel of a larger type. However, it has been found that even a 4-cu.yd. shovel works well. In ore-loading service no side boards are used on the body and two 4-cu.yd. dippers constitute a load. In stripping work, side boards are added, as shown in the view of a stripping operation (Fig. 3). Three dippers of 4-cu.yd. capacity make up a load. Pit loading in ore service has varied from 15.4 long tons to 18.2 long tons, with an average load of 15.7 long tons.

Table I—Time-Cycle Study With 15-Ton Truck, Louise Open-pit Mine, Cuyuna Range

Loading shovel used	Northwest 1¾ cu.yd.
Total haul, ft.	3,185
10% grade, ft.	2,135
Total lift, ft.	213.5
Time Cycle	
Loading time, min.	3.01
Hauling time, min.	8.00
Dumping time, min.	1.00
Return trip, min.	2.50
Total cycle, min.	14.51
Average loaded speed, m.p.h.	4.52
Average return speed, m.p.h.	14.47

Note: Above figures include delays at the shovel.

In laying out an open-pit operation involving truck haulage, 8 to 10 per cent grades out of the pit have proved successful in shortening the length of haul. This compares with a 2 or 3 per cent grade for locomotive haulage; hence the minimizing of haulage benches can be visualized.

Truck speeds for estimating purposes may be computed as follows:

	m.p.h.
Level hauls loaded, maximum	10
Downgrades empty[1], maximum	10
Upgrade, 5%	8
Upgrade, 7%	6
Upgrade, 10%	5

[1] Note: 10 miles per hour is used as the maximum speed downgrade only as a matter of safety.

To avoid danger of collision and to cut the length of return trip, grades up to 20 per cent have been used for the return road into the pit. A separate return road is always advisable where possible.

Curves on haulage roads are banked to effect easer steering of the loaded truck, and though a 50-ft. radius curve is desirable, the standard dual-rear-wheel truck can negotiate a 20-ft. radius curve readily.

Fig. 5 . . . DUMPING one of the successful 6-wheel trucks into a bin feeding the crushing plant at the Louise pit. When ore was loaded directly into the cars without crushing, a simple ramp was built, as shown in Fig. 1

A road to serve as a run-around is convenient, but not essential if an area is provided so that the truck may back into loading position at the shovel while the shovel is swinging and digging.

The most important point in assuring maximum tire life is the proper maintenance of roads. Bulldozers in the pit to level out spillage and a road patrol grader on main haulage roads pay dividends in saving on tire maintenance. A road sprinkler is also used in dry weather to reduce dust hazard to men and equipment.

Heavy repair work on the shovel necessitates the use of a light crane on caterpillar treads to replace the locomotive crane used formerly. Though the main or central repair shop is generally used for larger repair jobs, a field garage of light construction and sectionally portable is used for servicing and minor repairs. This field garage is located near the operation (see type of garage used in Fig. 2).

Fig. 4 shows a view of the Louise open pit on the Cuyuna range in which these 15-ton trucks were used. The haul road was laid out on a 10 per cent grade and a truck will be noted making a 20-ft.-radius banked turn about halfway out of the pit. This road is wide enough for two trucks to pass at any point. Note the run-around road in the pit bottom. The old railroad grade with the four switchbacks is still visible. This railroad grade averaged 2.6 per cent out of the pit, and the total haul was about 8,500 ft. as against 3,185 ft. for the truck haul.

A time-cycle study of this truck operation supplied the data given in

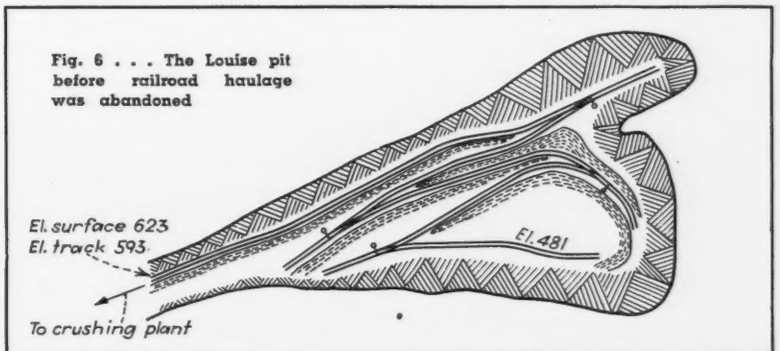


Fig. 6 . . . The Louise pit before railroad haulage was abandoned

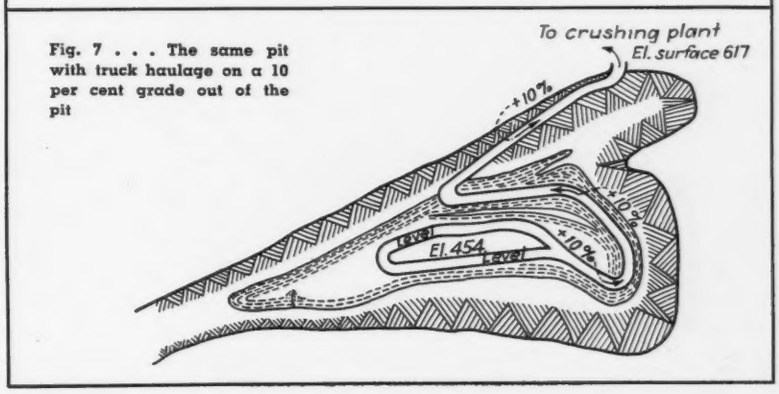


Fig. 7 . . . The same pit with truck haulage on a 10 per cent grade out of the pit

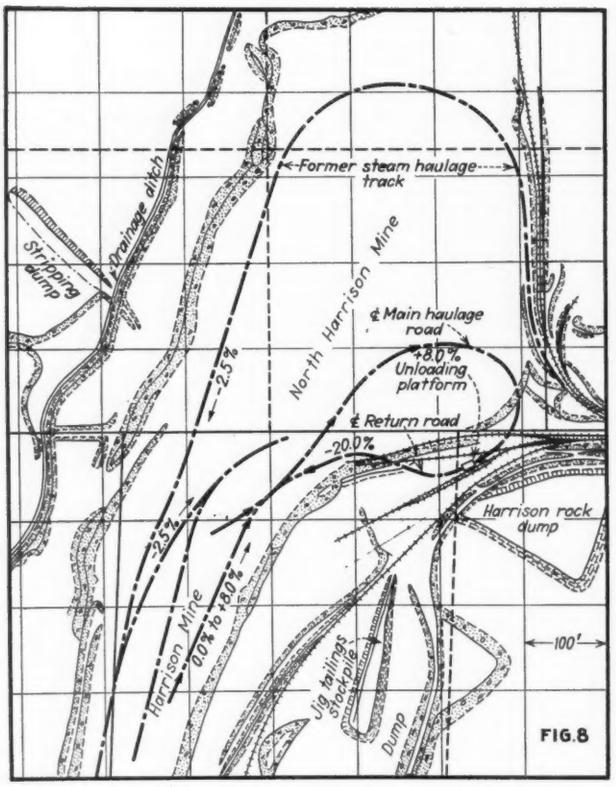


Fig. 8 . . . Truck road and railroad tracks as located respectively in the open pit (on the Mesabi) dealt with in Table II

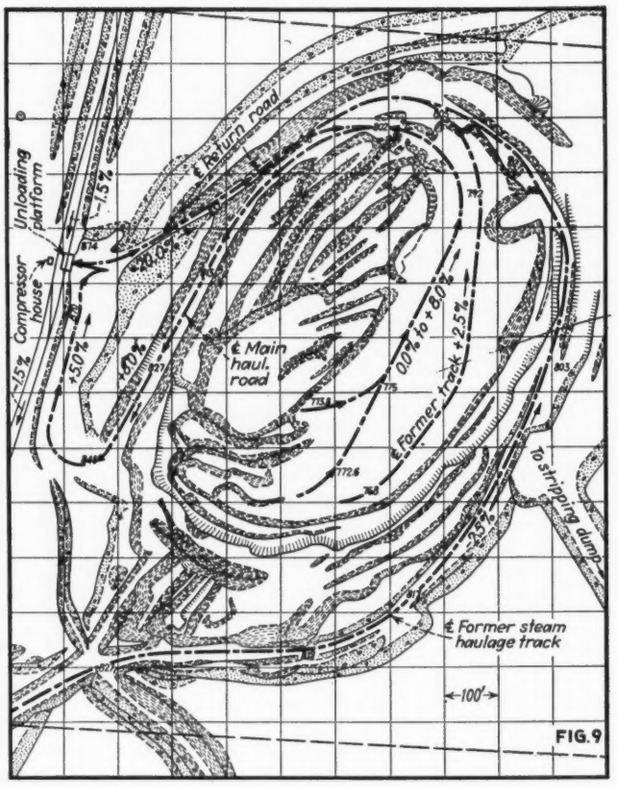


Fig. 9 . . . TRACKAGE and the succeeding truck roads as laid out in the Mesabi open-pit mine dealt with in Table III

Table I. In this operation the ore was dumped into a bin feeding the crushing plant which was formerly served by rail haulage (see Fig. 5). This view also shows one of the successful six-wheel units. When ore was loaded direct into cars without crushing, a simple ramp was constructed as shown in Fig. 1. On this operation, three trucks were able to serve the shovel as well as two locomotives had formerly served it.

Fig. 6 shows the layout of the Louise pit mentioned in the foregoing before railroad haulage was abandoned. Fig. 7 shows the same pit using truck haulage on 10 per cent grades out of the pit.

On the Mesabi operations also, complete time-cycle studies were made of operations in ore and stripping service. These studies are summarized in Tables II and III. In both of these operations, well-ballasted and surfaced roads were provided.

Fig. 8 shows a plan view of an open pit on the Mesabi with the layout of railroad tracks and the new truck road location.

In both of the operations cited in

Table II—Time Study of Truck Operation on Ore Haulage Mesabi Range Open Pit

Total Haul: 4,200 to 4,600 ft., 0.8 mile.
Haul: 800 to 1,000 ft., level to plus 4%; (400 ft. wet and rough); 1,800 ft., plus 8%.
Return: 800 ft., minus 20%; 800 to 1000 ft., level to minus 4%.
Vertical Lift: approximately 155 ft.
Loading: One type 480 2-cu.yd. Marion shovel. One type 120B 4-cu.yd. Bucyrus shovel.
Trucks: Nine assigned to operation. Eight in line and one truck for servicing. Four-cubic yard shovel given preference in loading.
Digging Conditions: Varied as to rock content, showing loading time varying from 0.6 to 2.6 min. per load

Time Cycle

Truck waiting at shovel, min.	0.8
Interval between trucks at shovel, min.	*0.3
Loading time, min.	0.9
Traveling time—shovel to dumping ramp, min.	
Level haul, min.	0.9
Plus 8 per cent grade, min.	3.5
Dumping time, min.	0.8
Return time, min.	1.5
Delay waiting for shovel or dumping, min.	0.9
Total cycle, min.	9.6

* "Interval between trucks" in table is for run-around. This time increased to 0.6 min. when trucks backed 50 ft. to load. This does not denote a delay, since shovel is swinging and loading bucket during this period.

Table III—Time Study of Truck Operation on Ore Haulage Mesabi Range Open Pit

Haul: 100 ft., level
400 ft., plus 8%
525 ft., level
500 ft., plus 8%
100 ft., plus 4%
300 ft., plus 7½%

Total haul: 1,925 ft., 0.36 miles
Return trip: 450 ft., minus 19%
625 ft., level to minus 8%

Total return: 1,075 ft., 0.20 miles
Total round trip: 3,000 ft., 0.56 miles
Vertical lift approximately 100 ft.
Loading: One shovel, Type 4160 Marion, 4 cu.yd.
Trucks: Seven assigned to operation. Six in line and one truck for servicing.
Digging Conditions: Uniformly good. Comparatively free from rock and well blasted.

Time Cycle

Truck waiting at shovel, min.	0.3
Interval between trucks at shovel, min.	0.3
Loading time, min.	0.9
Traveling time, shovel to dumping ramp, min.	3.6
Dumping time, min.	0.8
Return time, min.	1.2
Total cycle, min.	7.1

Table IV—Time Study of Truck Operation on Stripping Haulage Mesabi Range

Total haul: One mile, mostly level.
Loading: One 4-cu.yd. Marion shovel.
Digging conditions: Fair. 18 to 24 in. of frost in ground. Bank 20 to 25 ft. high. Stripping chunky and much clay.
Weather: Very cold, 20 to 35 deg. below zero. Snow on ground.

Time Cycle

Time waiting and delayed, min.	1.22
Time loading, min.	1.40
Time hauling, min.	6.71
Total cycle, min.	9.33

Tables II and III, respectively, trucks delivered the ore into stripping cars to be hauled to the washing plant. Ramps were provided for dumping direct from trucks into the cars. Cars were spotted at the ramp by means of gravity-drop tracks and the car brakes controlled by the car spotter. Compressed air for brakes was furnished by a portable compressor.

Fig. 9 shows the arrangement of trackage and the succeeding truck roads in the pit to which the data given in Table III pertain.

Many time cycles have been studied on stripping operations. The time study set out in Table IV represents a mid-winter operation under severe weather conditions.

Though railroad equipment still provides the logical solution to the operation of the largest open pits, the truck has proved its adaptability to the medium or average-sized open-pit operation and is especially valuable in a smaller open pit. Where a group of properties are operated in close proximity, the truck provides an extremely flexible unit in both ore and stripping service.

Considerable argument is provided in discussion between truck and tractor advocates as to the superiority of each type of unit, but in general it may be assumed that where hauls are short—not over 800 to 1,000 ft.—the tractor and wagon has the advantage, but where the haul exceeds this distance, the truck stands out in performance.

The short space of time that has elapsed since large trucks were first used on the iron ranges of Minnesota would preclude any long-range prediction as to the final extent of their use in the future. Their performance, however, to date has led close observers to form the conclusion that the truck is here to stay.

When Handling Mercury

Precautions that should be followed in all plants

BECAUSE of the insidious nature of chronic mercury poisoning, and particularly because of the obscurity and variation of the early symptoms in different individuals, prevention is of paramount importance, according to the General Electric Company's Handbook GEQ-104. The following recommendations are, therefore, enumerated to assist as much as possible in the prevention of the disorder. They are derived from experience which has been gained in work with mercury-vapor equipments and from various other sources, notably Bureau of Mines Bulletin No. 222, which in some cases is quoted verbatim:

1. Working places should be ventilated, preferably by mechanical means, so that there is always an abundant supply of fresh air.

2. A negative pressure should be maintained at all times in the furnaces of mercury boilers, stills, and similar equipment to prevent escape of fumes or dust.

3. When chipping, welding, or cutting used apparatus, wear a good tight respirator which receives a plentiful supply of fresh air through a hose.

4. For emergency work in case of accident to mercury equipment, or in mercury-laden atmosphere, where the use of an air hose would be awkward, use a gas mask with a canister approved for use with mercury vapor. The mask using Type N canister (see Bureau of Mines R.I. 2719 and R.I. 3187) is the best now known.

In case there is a break in a pipe containing hot mercury, leave the room at once. If he can do so safely, the man in charge may don a gas mask and remain just long enough to shut off the leak or furnace fire.

5. Locker rooms equipped with showers, wash basins, or fountains, and two lockers per man, should be provided for employees.

6. Mercury should be stored only in tight flasks or under water in suitable tanks.

7. Food should not be kept nor eaten near mercury or in mercury workrooms.

8. All applicants for employment in departments using mercury should be given a special examination at the company hospital.

9. Employees working with mercury should be given a physical examination every two or three months, and before returning to work after lost-time illness. They should report to the company physician immediately if ill for any reason.

10. Every employee should be informed of the dangers of poisoning by mercury and instructed how best to avoid them.

11. Spilled mercury is dangerous and spilling should be carefully avoided. Anyone spilling mercury should see that it is flooded with water and cleaned up at once. Pans containing water should be placed under all packing glands on valves and other equipment which may leak mercury; or, if the glands are hot or over a hot place, they should be connected to a suction pipe which will carry the fumes out of doors.

12. Never use an air hose to blow dirt or mercury off of the floor or mercury equipment. To do so is to stir up mercury which will immediately be breathed and thus absorbed through the lungs. Mercury may be picked up by means of a strong suction through a hose having a metal nozzle not over $\frac{1}{8}$ in. in diameter.

13. As personal cleanliness and personal hygiene are important factors in preventing poisoning by mercury, the following instructions should be given careful attention by employees: (a) Wash hands carefully before eating or handling anything that will be placed in mouth. (b) Always rinse mouth before taking a drink or eating. (c) Drink water and milk plentifully. (d) Never come to work without having eaten a substantial meal. With an empty stomach conditions are more favorable for the absorption of mercury into the body. (e) Take a hot shower bath, using soap, at the end of each day's work. (f) Change ordinary clothing for work clothing before going to the workroom, and work clothing for ordinary clothing at end of shift. The change should be complete, and the two sets of clothing should be kept from touching. Work clothing should cover the body well and be tight fitting at the ankles, wrists, and neck. A close-fitting cap or hat should be worn. Work clothing should be washed at least once a week. (g) When passing to leeward of fumes, hold breath as much as possible. Pass to the windward wherever possible. When it is necessary to be in fumes or dust, wear a fresh-air respirator or gas mask, approved for use with mercury, at all times. (h) After having been in fumes, dust, or soot, wash exposed parts of body, hands, and face, and rinse mouth well at the first opportunity. (i) There is danger in the handling and use of tobacco near mercury. Do not use it when on duty or carry it in your work clothes. (j) Constipation lowers the resistance to mercury. Regularity is very important. (k) Care of teeth and gums is most important. They should be kept clean and healthy and should be examined at least once every six months by a dentist. They should be X-rayed on engagement and once a year thereafter. (l) If employee feels sick, he should consult the physician.

Psychological Phases

Of the Accident Prevention Program

The instructor must regard himself as the leader of a study group

THERE IS ONE LAW that requires no court to interpret it and no executive to enforce it. Obedience to that law conserves life; disobedience often means death. It is the law of gravitation. Thousands of persons lose their lives each year because they fail to heed its plain commands or think they can violate it with impunity. Ever since man first appeared upon this earth he has been striving to find ways and means of escaping its penalties. The first real progress in this direction was made when man realized that it is his duty to use a certain amount of planning while about his daily labors. This is for his protection against injury. Little thought was given to the frequency rate or the severity rate of an accident years ago by management or workmen. Safety was thought of as only one item of the day's work. Today, however, thousands upon thousands of dollars are poured into funds for safety educational programs throughout the country every year—money spent by industry in order that employees may go about their work safely.

Management must formulate the policies of the safety program and actively support these policies so that interest may be aroused and maintained throughout the plant, from the supervisors down through the employees. A wholesome, intelligent, and friendly co-operation between management and employees is most necessary to eliminate or to decrease the severity and number of accidents. Co-operation will increase considerably when men are in groups, particularly when the instructor regards himself as a leader of a study group, and not a dispenser of abstract facts. He will succeed as a teacher in proportion to his ability to get his men to think about and participate in the topics under discussion. He cannot do this if he is too much on his dignity or tries to make the meeting formal and stilted. Men will look askance at any training program if the instructor does not show enthusiasm for it. Enthusiasm begets enthusiasm. In many instances, the campaign is brought to heights of enthusiasm, when suddenly and unexpectedly the instructor places the responsibility of the mass or group upon

S. W. Dean

Safety Director, Hayden Plant, American Smelting & Refining Company Hayden, Ariz.

the shoulder of his assistant or understudy. This is poor practice, and it is safe to assume that such arrangements in the composition of the training program will not achieve outstanding success. There can be no substitute for personal contact in spreading enthusiasm of any sort—especially in a safety educational program.

Adequate preparation must be made in advance, however, so that the lectures, demonstrations, and short discussions are given in a natural and serious way, and so that the men will not be standing around waiting for the instructor to get ready. Before the class is started, the aim should be clearly stated in full detail. This will focus attention on what is being done. One of the first outstanding rules of conduct for a safety director, to be discovered of a group of employees, is this: They can be led into safety habits, but it has as yet been impossible to compel them to be safe. This is obvious; every leader of any significance in written history has proved it in actual practice. It can be found in every workman's meek philosophy in almost every industrial plant today. Yet many plant records in safety are being shattered because such plants lack sound systems designed to obtain the utmost from the bits of psychological truisms, of which each of us has a portion. And if a study of plant personnel be made, and the findings be recorded and analyzed, this will probably be found: Only a small minority of the people really think; a somewhat larger percentage think they can think, and the great majority would rather pass away than think. In the mass of an organization the mentally indolent predominate unless the bosses see that they acquire sound thinking habits. These habits can be perfected only by practice. Experienced teachers all agree that we learn to do by doing. This is obviously true of manual skills. A man cannot be a good golfer without practicing with golf clubs. Neither can he acquire skill in thinking without utilizing his brains.

Groups, masses, or conference methods are the most powerful tools a safety director can develop. They promote habits of thinking, modify attitudes, and pool the best ideas of individual members so that the best thought on the subject will be available to all. Their informality tends to inspire confidence and to create a sense of fellowship between the leader and the group, and to break down the barrier between the higher and lower brackets, the office worker and the plant worker. Segregation of the groups should be handled skillfully, and in a manner that will not offend the sensitiveness of the men, for some are extremely touchy on the subject of understanding, and to belittle their knowledge would tend to goad their dignity and hurt their ego. A good group leader will respect a man's dignity; in fact, he will raise it merely by a word of praise during the course of training. The next tool at the disposal of the preceptor is the National Safety Council and its many posters, bulletin boards, plant papers, and foreman pamphlets, all of which are valuable aids to safety measures. Other tools which are excellent media to bring men together in small or large groups, and at the same time show apparent results in the plant daily accident records, are courses of instruction in first aid.

To get the wheels of the campaign started against the hazards about the plant, to reduce unsafe practices, and to plane the rough off the thinking machine of the plant personnel, first draw on the National Safety Council for posters for bulletin-board interest, and charts for your classes. Next, use material from the United States Bureau of Mines or the American Red Cross for a course of instruction in first aid to the injured. These are

among the most effective agents in an accident prevention program in keeping the employees on the job, and the injury cost down. First aid often means the difference between a simple injury and a serious permanent disability. It is not a substitute for medical care; rather it is, as the name implies, an emergency to fill the gap between the time the accident occurs and the arrival of the physician or ambulance.

The dressing of imaginary wounds, placing of splints, carrying the injured, and practice in artificial respiration become interesting when the instructor brings in case problems, either real or hypothetical, for discussion. A real case in which the men are interested at the time is best. It may be one of outstanding accomplishment or an unusual situation. Perhaps one of the men has had a case or has seen an interesting problem. This being true, let him express his conclusions before the group. This invites questions and forces thought, which is precisely the purpose of the training. There are men in every group who have good, constructive ideas, but who will be reluctant to talk because they cannot express themselves well. A good instructor will quickly catch the man's meaning and will express the idea for him, thereby relieving him of embarrassment and encouraging him to talk more. Avoid long lectures. They involve too much detail. A man does not fully appreciate ideas that are presented and then interpreted for him. Such a procedure requires too little effort on his part, making it easy for him to relax and indulge in day dreaming or peaceful slumber.

Interest in class can be maintained through a wide variety of information skillfully handled by the instructor. Statistical information, for instance, is seemingly a dry routine subject to most individuals; yet, such subject matter can be so arranged as to afford an extremely effective picture, enabling the men, foremen, and executives to visualize the contributory causes of accidents and the severity to the parts of the body affected. Chart talks are a stirring tool, and create a very effective discourse when presenting almost any subject. These charts enable the human camera to snap mental pictures as thoughts are offered.

Accident investigation is another subject that, when explained to the class, brings profitable results. Few people in an industrial plant realize the importance of this phase or the primary reason for adding accident investigation to a safety program. First, it corrects the causes of injuries and eliminates the chances of a recurrence, thereby reducing liability expense. Second, it is doubtlessly a breeder of ill feeling to men intermingled with accident causes. Third, analyzed suggestions have often brought about changes in plants which not only removed the hazard but also revolutionized and speeded up production in some departments.

It is, indeed, unfortunate that human beings "pass the buck" when an accident occurs. Each hopes that an alibi will suffice or that he can get by with the old-time idea that accidents will happen in spite of all one can do to prevent them. This thought in itself is an alibi, and the instructor must do all that he can to dispel it. Men in industry are prone to pass the responsibility of an accident down to the man below them, and in most cases it comes to rest upon the man who was injured. In turn, he endeavors to pass the cause on to his helper or his fellow worker. Thus one man in the accident and three or four men are all involved in an ill feeling toward the other because each has been blamed for the accident. Analysis will fix the responsibility, and the individual who is found lax will realize his breach in safety and usually take the consequences like a man.

The Purpose of Investigation Is Not Punitive

Investigation of accidents should not be regarded as a medium by which the investigating committee can make use of the facts to substantiate reasons for dismissal or the punishing of an offender, but rather as a means of bringing about complete understanding and fairness, and, above all, correcting the cause of the accident. The cause may then be corrected and dropped at that point, unless, of course, the offender is a habitual repeater or a cheat who cannot bring himself to see that he has previously been given an opportunity to fall in line with the educational program. Applying the analysis to the accidents does not stop at the reportable type, or those resulting in serious injury. Minor cuts and bruises will also bear investigation—a minor injury is a potential major accident. Minor or near-accidents many times expose some physical or supervisory causes of accidents in which no human beings are caught in an injury, but, which are still in every respect an accident. The fact that no one was standing near the scene of the accident does not nullify the necessity for getting to the bottom of the trouble.

Accident investigation should reveal two major points as to the cause of an accident. After the plant safety committee has studied the facts of the case, there are two divisions: (1) physical cause, and (2) supervisory cause. Physical causes are those over which the supervisor has little or no control, such as the physical condition of the plant, defective equipment, or layout of machinery. Supervisory causes are those which show neglect by supervisor or management, such as failure to instruct employees properly regarding the hazards of their jobs, unsafe practices, or the physical conditions of the employees, and incomplete instructions to them.

It is impossible to estimate the appalling loss of life, the waste of materials, lost time, and the ill will of the personnel that are caused by poor instructions or none at all. Incomplete orders have sent many a man to his death or caused the wreckage of valuable property. It is foolish to assume that because a man has proved his ability as a workman he has also proved his ability to proceed without safety instructions. On the contrary, familiarity is a breeder of accidents. No matter how much a man is told, he still has a certain amount of initiative prompting him to try some new method or process that he has originated to hasten his work to a finish, or perhaps to impress the "boss." Initiative plays a large part in a man's life at home or at work, and he should be praised for possessing it. Still, if a man is a possessor of an inventive brain, he should put his ideas up to his foreman in order to have them put into effect in the correct manner, not throw them together himself with a piece of half-worn wire and a few rusty nails. This invents a hazard instead of removing it. Small labor- and time-saving devices made on afternoon or graveyard shifts are generally crude for the lack of material to construct trinkets of the sort, yet they merit recognition when the idea is put into a safe, workable piece of equipment, and a safety director should, while about his daily tour of the plant, be alert for such things. Alertness on his part may prevent an accident. If complete analysis of his findings prove any change or innovation workable, he should help the originator develop the idea. Bails on overhead cranes, oil burners for reverberatory furnaces, speed wrenches, and other equipment too numerous to mention have been developed in just such manner. However, innovations may not wisely be put into use until strict trials over a long period of operations have demonstrated their value.

In offering praise in class, do it cautiously. Do not over-praise a man, and do not under-praise him. If the instructor should, unaimingly, direct his praise to the same man several times during the time in class, other individuals will notice it and mark the man as the instructor's "pet." So point your praise with prudence.

Industrial safety has passed from the old-fashioned method of brute force and cramming the throats of men with a series of undertakings set apart from the employee's normal functions, to the scientific stage of presenting a coordinated program of accident prevention activities, which would be an integral part of the day-to-day job of each employee.

Metallizing
In the Homestake Shops

Widely applied, it is used in particular for spraying with zinc all underground electrical equipment

METALLIZING is a process for spraying pure molten metals on any metallic or non-metallic surface without the use of flux and without preheating the object to be metallized, or coated. Although first developed some years ago, it is only in the last few years that it has won a firm place for itself in industry, according to B. F. Noonan, shop foreman, Homestake Mining Company, Lead, S. D.

The metal is applied with a small, specially designed spray gun which embodies a mechanism for drawing the metal in the form of wire through it, a chamber for melting the metal with the aid of oxygen and acetylene as it passes through, and a compressed-air actuated projector for atomizing this molten metal and blowing it at high velocity and great force onto the object to be coated, the surface of which must have been specially prepared. The deposit thus formed is dense, resembling a forging in character, and has an even hardness, without soft spots. The bond between it and the surface coated is very strong and is purely mechanical, and in no respect a fusion bond such as is obtained by welding. The object metallized does not require to be preheated, nor is there any overheating while the coating is being built up. In consequence, warping or distortion is said to be impossible. Much time can be saved, it is said, by building up worn parts thus.

Metallizing as used at the Homestake serves three purposes: To give protection against corrosion where desired. (2) To build up worn surfaces or provide a new surface different from the underlying metal. (3) Ornamental.

Metals thus applied, in the Homestake shops, purchased in the form of wire, are: 0.10 to 1.20 carbon steel aluminum, bronze, brass, and zinc. More zinc is used than any other metal. Consideration has been given to spraying the amalgamating plates with silver, but so far this has not been done.

Outstanding among the applications made of this metal treatment at the Homestake is the spraying with zinc of all switch boxes and other electrical equipment used underground. It is in this manner that the large amount of zinc mentioned previously is used. Floats for the concrete tanks that hold the drinking water underground are also sprayed with zinc. These floats are 18 in., 22 in., and 24 in. in diameter and 30 in. long. There are two or three on every level. They are made of black iron welded. The oil bottles used by machine (drill) men are similarly treated with zinc; also the holders used underground to contain first-aid kits. These holders are built of stout black iron welded and are of a simple design readily produced. (The kit is put in a Mason jar closed with a rubber cap and the jar is placed in this holder.)

These articles and others of like sort have to be thoroughly "sand blasted" first. Instead of sand, however, No. 18 steel shot is used, which is reclaimed. This "sand blasting" is very important. Unless a new rough surface be exposed, the metal coat put on is likely to peel off on occasion, just as paint might do. The coating, once on properly, does not readily come off. The record shows that floats and electrical equipment have been down in the mine for more than two years, and on being brought up, have had only a light scale on the metal surface. This has been cleaned off and the article sent underground again with the metallized surface as good as new.

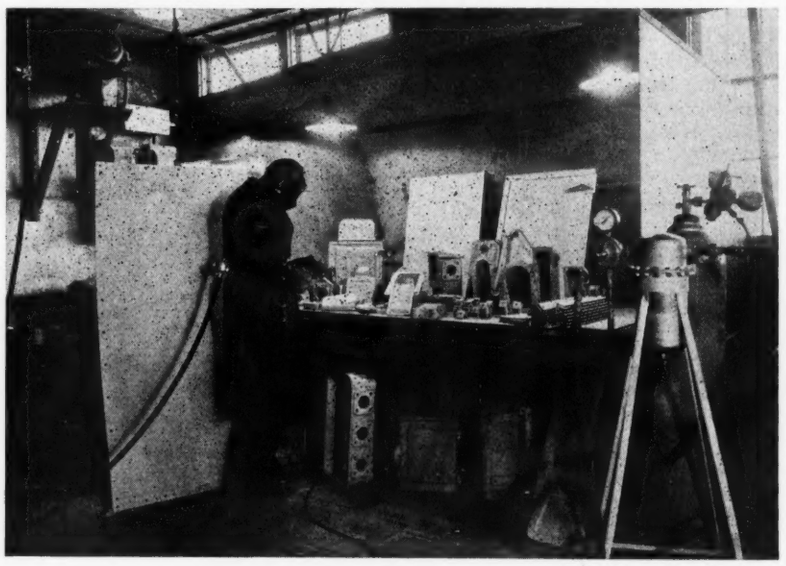
The "sand blasting" is done in a specially equipped room containing a cabinet about 5 ft. long by 30 in. wide, with a hood above and a hopper below for catching the shot. The floor of the cabinet consists of a grating made of iron bars spaced 1 in. apart, through which the shot falls with the hopper. The two sides and back and top of the cabinet are of sheet metal. On the front side is a canvas curtain, which can be raised to insert the "sand blasting" nozzle. Above the curtain on the front of the cabinet is a wire screen through which the progress of the work can be watched. This cabinet is used for preparing small objects.

Larger articles that are too big for the cabinet, such as the floats mentioned, are set on a metal table in the open room. Over this table is a hood which, with the hood of the cabinet, is connected to a 14-in. metal pipe which is exhausted by a 5-hp. fan.

For the "sand-blasting" operation, a so-called master generator made by the Ruemelin Manufacturing Company, of Milwaukee, is used. This consists of a tank for holding the shot, which is drawn off through a bottom valve into the connected compressed-air line, at the end of which is the blasting nozzle. The air pressure of 95 to 100 lb. per square inch is practically constant up to the nozzle.

When an object having a worn surface is to be built up or a surface of a material different from the stock is to be created, the preparation work is quite different. From among the objects so treated, such as brake pins, clutch pins, pump rods, or shafting that has become worn on a bearing, the clutch pins may be taken for purposes of illustration. This work is done in an adjoining room. Here a bar of 2-in. cold-rolled steel which had previously been turned down to provide six clutch pins 6½ in. long, spaced about ¼ in. apart on the bar (but not yet cut apart) and each one bored through with a ¼ in. hole at each end at right angles to the center line of the bar, was seen mounted on a lathe. Beginning with the first, each clutch pin was then turned down about five

IN THE METALLIZING SHOP at the Homestake Mine. Coating small objects



one thousandths of an inch and then given a rough thread cut to provide a good bond for the metal surface to be applied. The bottoms of the grooves thus cut are about 1/32 in. below the original surface of the bar. Next, the freshly exposed surface of the pin was immediately metallized with 1.20 carbon steel while the freshly prepared pin was still on the lathe and before the work of turning down the pin next to it along the bar was begun.

To do this metallizing a Mogul metallizer, made by the Metallizing Company of America, of Los Angeles, was used. One is shown in the illustration. It is connected to three lines, two for oxygen and acetylene respectively, and the third line for operating an air motor that serves to feed the metallizing wire into the resulting hot flame that melts and vaporizes it. As the flame impinges at right angles onto the pin rotating toward it (at various speeds) in a counter-clockwise direction, the metal is deposited on the surface of the pin. From the opposite direction a jet of air is played upon the pin to keep it from overheating. The Mogul metallizing tool, mounted on the tool carriage of the lathe, is caused to move horizontally so that the jet moves horizontally forward and backward along the rotating pin in a sufficient number of passes to give the desired thickness of metal. At the time the job described was being done the wire was fed with the jet at a rate of 8 ft. per minute. Approximately 150 ft. of No. 12 wire was consumed in building up a coating 3/16 in. in thickness. Loss of metal was estimated at about 15 per cent. The resulting coat was uniformly hard.

The metal coat thus deposited must next be wet ground. If dry-ground, it is likely to peel off. Turning, instead of grinding, is considered inadvisable, although it was stated that 0.2 and 0.4 per cent carbon steel can be turned. Any desired thickness can be built up, although if there are too many layers, peeling may result.

If properly applied, the coating is tenacious and practically part of the object coated, although it may be broken off possibly by means of blows under a power hammer which are sufficient to deform the underlying metal also. (At least, one such case was shown, where a ¼-in. coating had been broken off.) A demonstration of the quality of the coating was afforded in the case of an 8-in. aluminum sheave which had been coated with 1.2 per cent carbon steel and was then tested with a 1½-ton pull on a link chain passing around it at 50 r.p.m. The chain finally broke, but the coating on the sheave was not indented.

The shop has three men who can operate the metallizing equipment. They wear respirators when working with lead, copper, zinc, or bronze. The data here are presented with permission of Guy N. Bjorge, general manager.

Pure Manganese By Electrolysis

Bureau of Mines holds that production of the pure metal by improved process is commercially feasible

RECOVERY OF MANGANESE in high purity from low-grade ores by a method believed worthy of commercial application, and incidentally different from any previously recorded, is described in a recent report of the United States Bureau of Mines metallurgical division. Successive steps are: (1) Crushing and grinding. (2) Roasting to reduce higher manganese oxides to manganese oxide, done in an externally fired tube furnace, with cooling in a reducing atmosphere. The manganese oxide is readily soluble in dilute sulphuric acid, in contrast to quadrivalent manganese. (3) Leaching calcine with spent electrolyte, containing 2½ to 3 per cent of H_2SO_4, and settling and filtering to remove insoluble. (4) Purification of leach liquor to remove Fe, As, Cu, Ni, Co, and Pb, the Fe and As being removed (as ferric hydroxide with the arsenic occluded) by adding MnO_2 from anode slimes and agitating with air, and the Co and Ni, which are detrimental to the subsequent electrolysis, being removed either by cementation on zinc or precipitation by a mixture of potassium pentasol and sodium ethyl zanthates. Copper, if present in excessive amounts, can be removed by cementation on iron or zinc before the iron is removed. Zinc can be removed as the sulphide.

The solution, after being purified, is not allowed to come into contact with anything but "chemical lead" and is stored in a lead-lined tank. Sulphur dioxide is added to the tank until the liquor shows a concentration of 0.1 gram of SO_2 per liter.

Power for electrolysis was supplied by a three-unit motor-generator set consisting of two 750-amp., 6-volt, 1,150-r.p.m., double-commutator generators mounted on a common bed plate and direct-connected to a 15-hp., 3-phase, 440-volt, 60-cycle motor. Separate excitation was used for voltage adjustment.

In the tests made in a plant designed for an output of 15 lb. of metal per day, electrolysis was carried out in a lead-lined wood cell having anodes of corroding-grade lead ¼ in. thick, with a submerged width of 16 in. and depth of 29 in., and stainless-steel cathodes, separated by canvas diaphragms. The cathodes were of 10-gage sheet steel, with both surfaces buffed. The steel was a low-carbon alloy containing 17 per cent chromium.

During operation, the manganese content of the catholyte feed was 24 to 26 grams per liter; pH 7.2 to 7.6; that of the catholyte within the diaphragm frame was 8 to 10 grams per liter, pH 9 to 9.2; and the manganese content of the anolyte 3 to 6 grams per liter and sulphuric acid 25 to 30 grams per liter. The spent electrolyte contained approximately 3 grams per liter of manganese as $MnSO_4$, 5 grams per liter of manganese suspended as hydrated manganese dioxide, the original approximate 200 grams per liter ammonium sulphate, and 30 grams per liter sulphuric acid. After filtering out the MnO_2 the filtrate was re-used, part of it being recirculated through the cells and the remainder is then used with additional acid to treat the calcine again.

Ores experimented with included a wad-type ore from Nevada; a mixture of hausmannite and bementite with some manganiferous carbonate from Washington; rhodochrosite from Butte; and a low-grade ore from the Artillery Peak district, Arizona. Operating data on the electrolysis of the Nevada and Washington ores are given in the table.

Operating Data, Electrolysis of Nevada and Washington Ores

Nevada Ore

Group	Average Cell Voltage	1,000 Ampere-Hours	Total Mn Deposition, Pounds	Current Efficiency, Per Cent	Power Consumption Per Pound Mn, Kw.-Hr.
1	3.98	60.84	66.4	48.3	3.647
2	4.06	60.48	67.7	49.5	3.627
3	4.07	60.20	70.5	52.6	3.475
Totals	4.04	181.52	204.6	49.9	3.584

Average cell temperature, 31° C. Average current density 18 to 20 amp. per square foot.

Washington Ore

	4.3	6.72	8.4	55.6	3.44

Cell temperature 21–23° C.

Diamond Drills for Stoping —A New Field at Noranda

Bulk of ore supplied the smelter is broken with long holes thus put in or drilled with sectional steel

Fred S. Dunn
Stope Engineer
Noranda Mines, Ltd.
Noranda, Que.

IN THE EFFORT to lower costs in mining its copper-gold deposit in northwestern Quebec, Noranda Mines has developed a system of drilling holes up to 65 ft. in length for breaking ground. The property is one that has been under intensive development for the last ten years, and is now producing about 85,000,000 lb. of copper and 280,000 oz. of gold per year, in addition to being the world's largest provider of selenium. To do this requires the hoisting of 6,400 tons per mine day, this tonnage comprising 3,400 tons of low-grade sulphide ore, 1,600 tons of higher-grade sulphides, and 1,400 tons of high-silica fluxing ore.

The ore occurs in numerous irregular masses, usually lens-shaped, which stand vertically or nearly so. These vary in size from a few thousand tons up to several million tons. The two that are by far the largest are known as the "Upper H" orebody, extending from surface to the 1,250-ft. level, and the "Lower H," which starts at the 1,250 ft. elevation and thus far has been developed to 3,000-ft. depth. In cross-section these two bodies are 600 ft. long, and vary in width to over 500 ft.

Mining at Noranda in the beginning was done chiefly by the inclined-raise method. This consisted of vertical sections developed with raises crossing the orebody at intervals of about 27 ft. These raise systems were inclined at 40 deg., and were driven one above the other at 26-ft. centers. With orebodies thus developed, selective mining was done by slash and bench methods, leaving pillars where necessary.

In recent years the horizontal sublevel stoping method has replaced the raise system, and is used in mining the "Lower H" orebody and the smaller low-grade deposits.

Up to the end of 1933 all mining at Noranda was done with solid drill steel. This was made in lengths up to 20 ft. for open-cut work on surface and to a maximum of about 12 ft. for underground purposes.

In the course of mining large tonnages from the "Upper H" orebody by the inclined system, certain floor pillars 45 ft. thick were left in accessible from above and below. To mine these pillars from raises in their centers seemed to be the safest and best method. To do this required the drilling of 20-ft. holes from confined workings about 7x7 ft. in size. The standard solid drill steel was useless under these conditions, inasmuch as a working space of at least 12 ft. was required for changing steel. Finally, it was decided that jointed drill steel would be best for the job.

Intensive work on the development of a jointed or sectional drill steel was begun at the outset of 1934. The greatest difficulty here proved to be in obtaining a joint strong enough to withstand the vibrations set up in drilling, and small enough to permit its clear passage into the boreholes. After several months of testing a suitable drilling equipment was developed.

When the floor pillars in one stope had been drilled with sectional steel and blasted, it was found that the cost per ton broken was low. This, coupled with the fact that the method afforded safer working conditions for the miners, led to the gradual adoption of the method throughout the mine.

The diamond drill was first used for stoping purposes at Noranda in the spring of 1935. During the mining of one of the surface orebody pillars, a condition was met with which required a few holes to be drilled to a length of 40 ft. These were first drilled to a depth of 20 ft. with sectional steel, and a small diamond drill was then introduced to deepen certain of them as required. Due to the fact that the ground was hard, the diamond-drilling, when interpreted in terms of cost per ton, compared favorably with the drilling with the sectional steel. This helped to confirm the previous belief of a possible field for diamond drilling in stoping, and led to further study.

At present the bulk of the ore supplied the smelter is drilled with sectional steel or diamond drills.

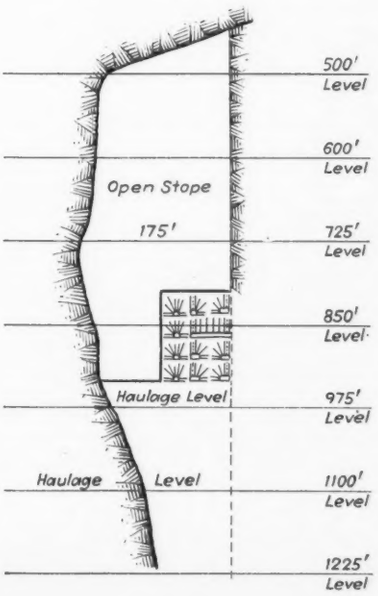
Inclined Raise Stoping With Sectional Drill Steel—Sectional steel has made it possible to carry on cheap open-stope mining to an unusual extent with comparative safety. Strong wall rocks and tough ore make it possible to leave large underground openings without support. The most outstanding example of this is provided in the mining of the "Upper H" body. Stoping has now opened up a room 350 ft. long by about 175 ft. wide and over 450 ft. high. If there are no evidences of caving, it is planned to increase its height to more than 600 ft. before back filling is begun. This orebody was developed for the inclined raise system previous to the introduction of jointed steel at Noranda. The old bench method with solid steel has been entirely abandoned

in favor of mining with sectional steel. The ore is being drilled according to layouts with holes placed in rings or lines to suit the conditions. Safety for the miners working in the stoping area is made possible by doing the drilling well in advance of the blasting, and providing manways to more solid zones at convenient points. Blasting is the most dangerous operation and is all done on night shift by experienced crews. The ore is blasted out in benches, retreating from the top of the stope down. This provides a roof of ore about 20 ft. thick above the blasters to protect them from falls of ground.

The system provides a continuous flow of freshly broken muck, and most of the 3,400 tons of concentrating ore hoisted per day is supplied by this one large stope. The method is flexible in that it may be carried on to any limit or stopped if signs of caving occur.

Fig. 1 shows a section across the the width of this stope and illustrates how the opening is widened by slices. The stope was first opened up to 95 ft. in width, and mined down to the 975-ft. level. As no evidences of caving occurred, this stoping width was increased to 175 ft. Fig. 1 shows a partly mined slice, now in progress, with holes drilled ready for blasting. Fig. 2 shows a side elevation of the stope through the block now being mined, and illustrates the method of blasting the benches. Blasting in this area is done mostly with tape fuse. This operation consists of blasting a convenient number of holes whenever a fresh supply of muck is needed. Sometimes a larger blast is necessary to complete a bench. This is usually fired electrically for the safety of the blasters. It is of interest to note the drilling done well in advance of the blasting and the access manways leading to safety zones at the top of each raise.

Fig. 1 . . . INCLINED RAISE stope in "Upper H" orebody in cross-section. This shows how the opening is widened by slices



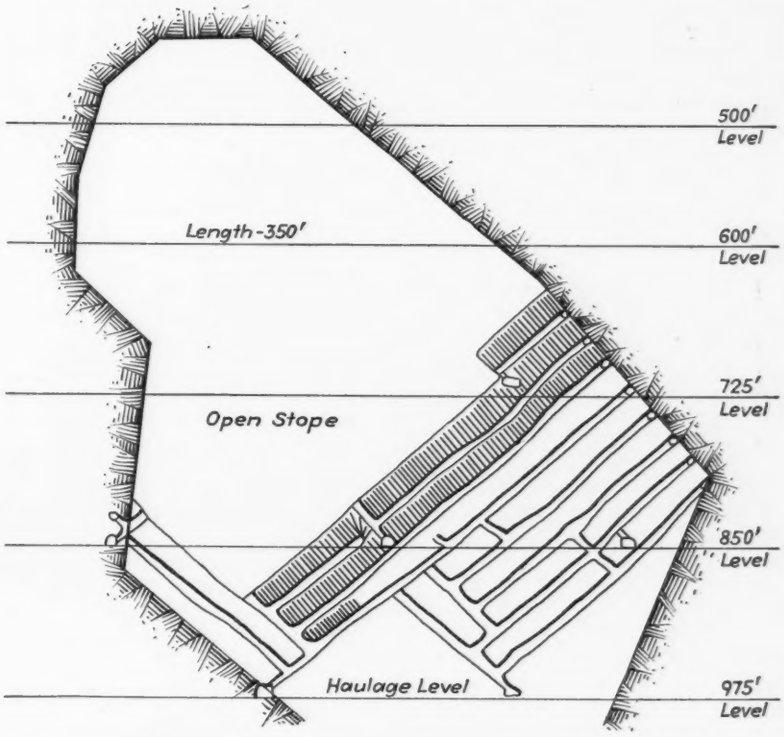


Fig. 2 . . . SIDE ELEVATION of the "Upper H" inclined raise stope through the block now being mined. It illustrates the method of blasting the benches

Draw holes are established at convenient points throughout the stope, with grizzlies and raises located to convey the ore to both the ninth and eleventh haulage levels.

Horizontal Sublevel Stoping With Sectional Steel—The horizontal sublevel stoping method is now used at Noranda wherever possible. The cost of these two systems compares fairly closely, but the safety and convenience of the horizontal work more than compensate for the labor saved due to gravity flow of the development muck in the inclined method.

Safe open-stope mining is also possible with the horizontal method of sublevel stoping. This system is used in mining Noranda's "Lower H" massive sulphide orebody, generally with stopes 60 ft. wide and vertical pillars 40 ft. thick. The ground at this depth (about 2,500 ft.) is fairly heavy, and it is not definitely known, as yet, what is the maximum size of opening that may be left without support.

The early horizontal stopes were laid out for the standard sublevel method of slashing and benching carried on from central manways driven on each sublevel. To create safer working conditions and to reduce costs, Noranda adopted the so-called "ring" system of stoping. The standard sublevel method is illustrated in Fig. 3 and the "ring" method in Fig. 3A. In the latter method the manway development on the sublevels is doubled. This extra cost of the "ring" method is more than offset by the fact that all subsequent slashing is eliminated, and the stope may be completely drilled on contract in advance of blasting. In addition, the blasting results to date seem to indicate that the "ring" method produces a more finely broken ore.

One of the chief objections to the bench system is that portions of the benches sometimes cave during slashing. This resulted in coarse muck and increased the secondary blasting costs.

Both the bench and the "ring" types of stopes are started in similar manner. One end of the stope is slotted out from a starting raise, and the working face is retreated by vertical slices. Secondary blasting may be done from the stope floor or on the grizzlies.

Stope blasting with the "ring" method is almost always done on Saturday nights. The holes in one complete slice are loaded and blasted electrically with three delays. It is believed that an instantaneous blast would break up the ore better, but it is feared that the resulting concussion might weaken the pillars. About 6,500 tons is broken per blast in the "Lower H" sulphide stopes.

Horizontal Sublevel Stoping With Diamond Drills—For drilling long holes in hard abrasive ore the diamond drill is finding a new field in stoping at Noranda. The drilling of 20-ft. holes with sectional steel in hard ground has proved slow and costly. The miners have difficulty in drilling due to gage loss. They find it is often necessary to use several sets of sharp steel in drilling one hole. This expense, coupled with that of drilling labor, results in

a high cost when spread over a small footage drilled per shift.

Stoping tests to date show that the apparent high cost of diamond drilling, when interpreted in terms of cost per ton of ore mined, is comparatively low. The high cost per foot of drilling is offset by a reduction in the amount of stope development necessary, and by the better breaking qualities of boreholes up to 65 ft. in length. In diamond-drilling, moreover, the sublevels may be spaced at greater intervals, and larger burdens of ore can be broken per foot drilled and per pound of explosive.

At present four small prospector-type diamond drills are employed continuously in one rhyolite or flux stope.

The slash-and-bench method of stoping with the diamond drills was tried out thoroughly and finally abandoned in favor of the "ring" method. Fig. 4 illustrates the "ring" system now in use.

Long-Hole Blasting—The secret of successful long-hole electric blasting is to have the loading and the connecting-up done by one shift. When two crews of different shifts take part in the same blasting operation, misfires sometimes occur, and it is usually impossible to trace the mistake.

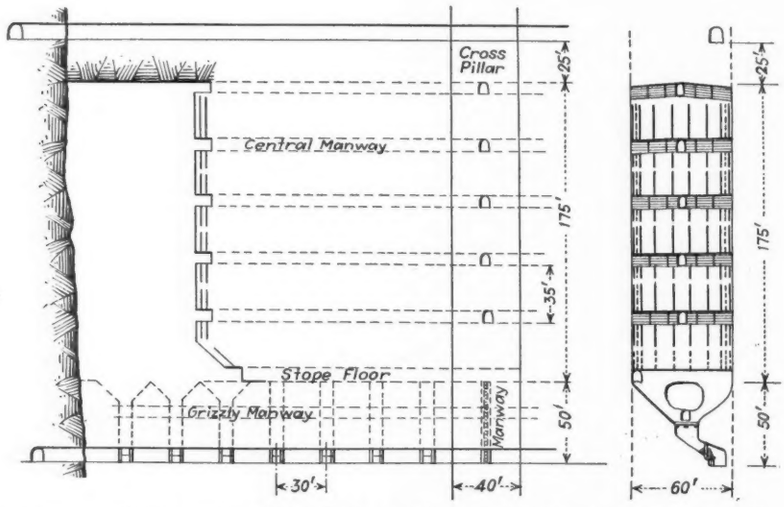


Fig. 3 . . . BENCH or standard method of sublevel stoping formerly used at Noranda, with vertical stope faces. Rock drills and sectional steel are used

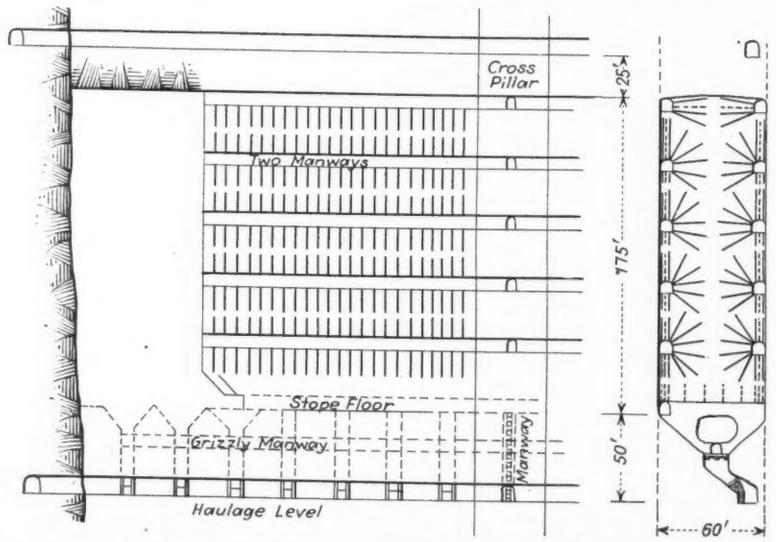


Fig. 3A . . . RING METHOD of sublevel stoping with rock drills and sectional steel, developed at Noranda. Compare with Fig. 3

A blasting crew consists of a leader and one or more experienced miners. In large blasts these may be assisted by others who help transport the powder to the working place.

The size of electric blasts set off at Noranda varies from a few holes up to the largest of 93,000 tons of rock, which was blasted instantaneously. The most common are those breaking from 3,000 to 10,000 tons per blast.

For ease in loading, the long diamond-drill holes are usually directed downward. The maximum upward inclination allowed is about 15 deg.

Clearing the sludge from diamond-drill holes is done with $\frac{3}{8}$-in pipe connected to the air line. Lengths of this are coupled together until the bottom of the hole is reached. Where several sections are drilled ahead, the holes are often shaken and damaged due to the concussion as a result of blasting preceding rings. Standard diamond-drill rods fitted with a chopping bit and connected to both the air and water lines are used to overcome this difficulty. Loose rock or cave is chopped out and the holes are flushed and blown.

The chopping operation is best done between blasts rather than during loading. This avoids rushing the work during the week-end blasting periods and allows plenty of time to overcome any difficulties met. The down holes are plugged after blowing, but in wet workings the water often seeps in and partly or completely fills the holes before loading is begun. Under such conditions, the powder has to be pressed gently to the hole bottoms to prevent jamming.

Tamping the $1\frac{1}{8}$-in. diameter powder into the $1\frac{3}{16}$-in. diameter diamond-drill holes is done with specially constructed sticks, described later. In this operation the powder sometimes becomes lodged and hangs up in the holes, due to slips or caved ground. No serious difficulties have been encountered to date, as the holes usually break despite this.

Special flexible blowpipes (described under equipment) are used in clearing the sectional steel holes, and are much more convenient than the jointed pipe or drill rods.

Polar Forcite gelatin (40 per cent strength) is used in blasting the diamond-drill holes. Both this and the 55 per cent Polar ammonia dynamite have been found satisfactory in the case of the shorter jointed-steel holes.

The burden broken per pound of powder has varied up to 9 tons, but the most common are from 4 to 6 tons per pound. Low primary powder consumption is possible due to the ore falling considerable distances to the stope floor after the blast. This tends to break it up further and reduces the secondary blasting costs.

Instantaneous blasts are used at Noranda whenever possible, except in important pillar zones where it is feared that heavy shocks might have a weakening effect. These insure a more complete discharge of all the explosive, and help to eliminate the presence of "bootleg" (stray powder) in the stopes.

Equipment—The standard sectional steel in use at Noranda was designed for drilling 20-ft. holes from openings of 7x7 ft. minimum size. Holes have been drilled up to a length of 40 ft. in soft ground, but it is difficult to go beyond the specified limit in hard ground.

The sectional steel drill rods are made up in 2-, 4-, and 6-ft. lengths, convenient for 2-ft. runs. To eliminate steel wastage the new rods are made slightly longer than specified and allowed to remain in service until slightly under size. When a 6-ft. section be-

comes too short, it is made into a 4-ft. and then into a 2-ft., before discharging.

The Carr type of cross bit with 90-deg. cutting angles and 7- and 15-deg. clearance angles is used. These bits are provided with gage variations for every 2 ft. drilled as follows: starter gage, 2 7/8 in.; 4-ft. gage, 2 in, and 6-ft. gage, 1 13/8 in. The bits for 8-, 10-, 12-, 14-, and 16-ft. changes are each equipped with a gage drop of 1/8 in. A further drop of 1/8 in. is allowed in the 18-ft. or final gage, 1 5/8 in. in diameter.

The first three bits, used with the starter, the 4-ft. and the 6-ft. lengths, are made of 1-in. quarter-octagon, ordinary, high-carbon drill steel. All of the jointed steel is made of 1 1/8-in. diameter round, hollow rods. High-carbon steel is used in the bit sections, but the shanks and fillers are composed of fatigue-resisting alloy steel.

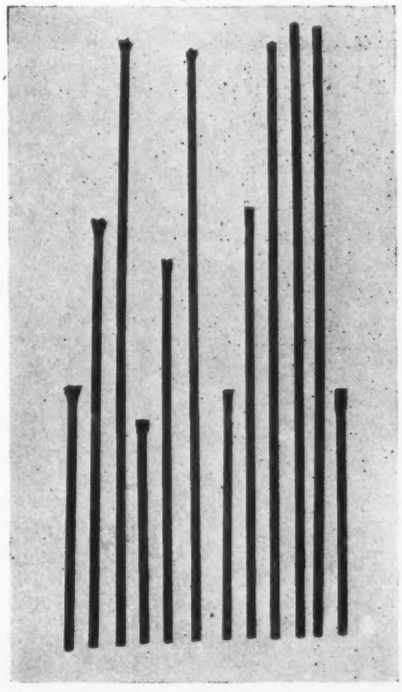
Shanks vary from 4 to 6 ft. in length, and are squared at one end to fit the chuck of the rock drills and threaded at the other for jointing with bit or filler. The fillers are threaded at both ends, and are made in 2- to 6-ft. lengths. The bit sections are cut in lengths of 2, 4, and 6 ft., and are threaded at one end only.

The standard thread in use is a round, left-handed type, with five threads per inch. This has proved to be the most serviceable, inasmuch as the rotation of the drill, which is to the left, insures a tight joint, and the rods are easily coupled and uncoupled.

The couplings are threaded to fit the rods and are 1 1/2 in. in outside diameter by 2 1/4 in. long. They are made of tough case-hardened steel.

A set of steel suitable for drilling

Fig. 5 . . . SET OF STEEL suitable for drilling a 20-ft. hole. Note that only nine bits are provided



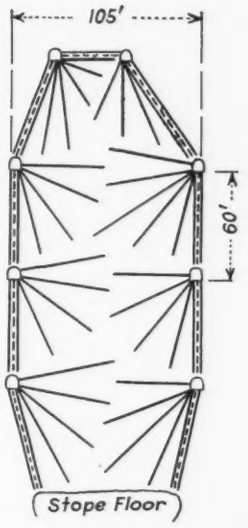


Fig. 4 . . . RING METHOD of horizontal sublevel stoping, when using diamond drills instead of rock drills. In cross-section

a 20-ft. hole is shown in Fig. 5. It is of interest to note that only nine bits are provided for the 20 ft. of drilling.

In such cases the 12-ft. bit length is used in drilling 4 ft. This is necessary to provide clearance for the coupling, and is made possible by the introduction of the 2-ft. filler. Where holes are drilled to greater depths, the 8-, 10-, and 12-ft. bits are used accordingly beyond their 2-ft. capacities.

The accessory equipment in use with jointed drill steel is illustrated in Fig. 6. In this photograph the objects numbered 1, 2, and 3 are fishing tools used for recovering broken steel and coupling from the drill holes. They are threaded to fit the standard drill rods. For recovery of a broken steel, tool No. 1 is driven into the water hole of the broken section and used to remove it. If this fails, the broken steel is gripped from the outside by using tool No. 2, which is a shell provided with a slight taper on the inside. Tool No. 3 is a larger shell similar to No. 2, and is used for fishing broken couplings. No. 4 is a standard coupling, and No. 5 is a long-arm support clamp. These clamps are attached with a drill rod as a prop and are useful for steadying long arms during drilling. No. 6 was developed for pulling stuck steel from drill holes.

Special flexible blowpipes are provided for blowing the drill holes. These consist of a convenient length of water hose fitted with a 5-ft. section of 3/8-in. pipe at one end, and a standard valve with fittings for air-line connection at the other.

Wooden loading sticks cut in lengths of from 4 to 5 ft., and coupled together with leather thongs, are used for loading the long sectional steel holes.

In diamond drilling, the sludge is blown from the holes with 6-ft. lengths of 3/8-in. pipe coupled together with standard threaded pipe sleeves. Blowing the diamond-drill holes is a slow operation that could be improved.

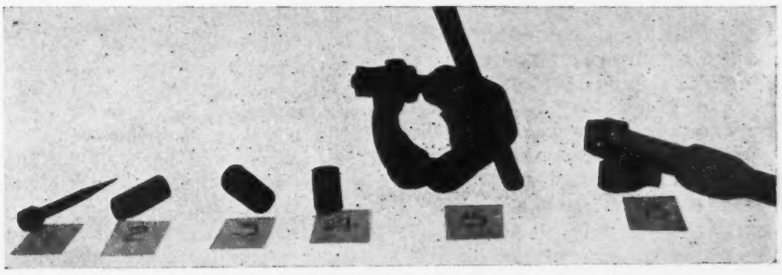
For loading the diamond-drill holes the blasters use ordinary garden hose threaded with 3/8-in. cable for stiffening purposes, and attached to a 24-in. length of brass tubing filled with lead. This heavy metal end is tipped with wood to be doubly sure that no sparks would be generated during tamping operatings. Jointed wooden loading sticks are used for loading any holes that are inclined upward.

Rock drills of both 3- and 3 1/2-in. bore diameter, equipped with good blowing devices, have been found satisfactory for sectional steel drilling.

Stoping with diamond drills at Noranda has almost all been done with light prospector-type machines, using rods from 1 up to 5 ft. in length, with an outside diameter of 1 7/8 in. In this work, coring bits are used for starting the holes and for drilling any very hard spots encountered, but most of the drilling is done with special non-coring bits developed at the mine. These are known locally as "bull-nose" bits, because of the rounded shape of the cutting end. Fig. 7 illustrates a coring bit and one of the types of "bull-nose" bits experimented with. The "bull-nose" bit is equipped with grooves and a small square or oblong hole through its center for water supply. Use of a square water hole helps to break up any small core that is made and prevents blocking. These bits tend to speed up the work, inasmuch as the need of frequent pulling of rods for core disposal is eliminated.

In general, an excellent opportunity has been had at Noranda for trying

Fig. 6 . . . ACCESSORY EQUIPMENT used in drilling with sectional steel at Noranda. The various tools are explained in the text



Rhokana Refines Copper at Nkana

The plant is the first of its type to be built on the continent of Africa

THE modern electrolytic and furnace refinery, installed at the Nkana plant of the Rhokana Corporation in Northern Rhodesia in 1935, to make finished shapes from a portion of its blister copper, is of particular interest because (1) it converts an impure blister to refined copper by electrolytic means and (2) it is the first installation of this kind in Africa (electrolytic copper has been made by Union Miniére du Haut-Katanga, in the Belgian Congo, since 1922 by electrolysis of leaching solutions), according to A. E. Wheeler and H. Y. Eagle in a paper recently presented before the Electrochemical Society.

Nkana blister copper is exceptionally pure in respect to the total of all impurities, and its precious metal content is too low to justify the use of electrolytic refining simply to recover these values. However, it does contain an extraordinary amount of the objectionable element bismuth, which precludes its refining into the highest grade of copper by fire-refining methods only. Electrolytic refining seemed to be the only means of lowering the bismuth content satisfactorily.

The refinery consists essentially of an anode department, making anodes of refined blister; an electrolytic tank house; and a furnace refinery, in which the cathodes are melted and cast into commercial shapes. Auxiliary to these are the electric substation, slimes-treatment plant, steam boiler plant, and interdepartmental railway. Rated capacity, as built, is 36,500 short tons of refined copper per year, with provision for future extension up to five times present capacity.

Anode Department—This occupies an extension of the converter and casting aisles of the smelter and takes molten blister delivered from ladles directly into the refining furnace by the converter aisle cranes. The anode furnace is of the cylindrical, tilting type, 13 ft. in diameter by 30 ft. long, lined with magnesite brick and fired with pulverized coal from a No. 70 Impax unit pulverizer. It is operated on a 24-hour cycle, the usual oxidation and reduction steps being carried out to yield anode copper of proper set and composition. Refined copper is poured into an hydraulically operated pouring spoon and delivered to the casting machine.

This is a Walker wheel, 24 ft. in diameter, with fourteen cast-copper anode molds, each provided with a single push-pin for extracting the anode. Mold temperature is regulated by adjustable water sprays. After being sprayed with pulverized silica mold wash, the molds are again ready for pouring. Anodes are poured carefully to a definite depth mark. Anodes produced are (1) standard anodes used for cathode production weighing 625 lb. each, and (2) stripper anodes used for starting-sheet production weighing 700 lb. each.

Anodes are removed from the casting wheel by the anode-bosh crane which deposits them in the anode-bosh in a rack $4\frac{1}{8}$ in. apart c. to c., where

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(*Continued from page* 41)

out and comparing different stoping methods, due to the occurrence of numerous orebodies of various shapes and sizes. The horizontal sublevel method is now preferred for mining both the rhyolite and the sulphide ores.

About 750,000 tons of sulphide ore has been mined by the slash and bench sublevel method in the "Lower H" stopes. Over 200,000 tons of hard flux ore was mined in a similar manner, using rock drills for slashing and diamond drills for benching.

In the more recently adopted "ring" method of horizontal sublevel stoping, about 75,000 tons has been blasted in the "Lower H," and 50,000 tons of rhyolite with the diamond drills.

Originally almost all of the flux orebodies were mined by shrinkage methods. This was considered the cheapest, because a minimum of development was necessary and the ore could be followed into any bays to its limit as stoping progressed. At present only the high-grade rhyolites and the occasional small, rich sulphide deposits are mined by shrinkage systems.

Shrinkage stoping has been avoided in the larger sulphide bodies because the oxidation of the broken ore in the stopes is considered a fire hazard, and in the case of the lower-grade bodies, "stale" ore is difficult to mill.

Of the two sublevel methods used at Noranda, the "ring" system of drilling from manways is preferred for wide stopes. Best results are obtained in mining large blocks of ore with predetermined limits and straight vertical walls.

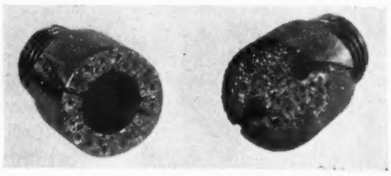


Fig. 7 . . . NON-CORING or "bull-nose" bits used extensively in diamond drilling long holes for stoping purposes at Noranda

In cases where the limits are irregular and the orebodies are inclined, more supervision is required. The drilling is done from manways which may twist and bend in following irregular limits, so that separate drilling layouts are required for each section. This has a tendency to increase costs, and it is difficult to mine all the ore without breaking some waste rock.

The slash-and-bench method of subleveling is used for mining the narrower sulphide bodies. In such cases a single manway is driven in the center of the body on each sublevel, from which slashing and benching are carried to the ore limits. The relatively small tonnage of ore in narrow bodies is insufficient to cover the higher development cost of the "ring" method.

Almost all of the long-hole drilling is done on a contract basis. Two men are employed in measuring up the holes and looking after the contracts. About 25 rock drills and 4 diamond drills are engaged continuously on long hole mining, working two 8-hr. shifts per day.

Most of the drilling with jointed steel is done in sulphides. The footages drilled per machine shift have varied from a low of 25 ft. in hard abrasive ground to a high of 145 ft. in soft sulphides. The average for 1937 was 67 ft. per drill-shift.

In stoping work, the light prospector-type diamond drill has made footages from a low of 15 ft. to a high of 45 ft. per drill-shift. The average, including moving, has been about 25 ft. per machine-shift.

A light, high-speed diamond drill, built especially for stoping purposes, has drilled as low as 22 ft. and as high as 65 ft., and an average of 37 ft. per drill-shift. These results were obtained from the drilling of only about 2,000 ft. in hard rhyolite and diabase.

Until recently the design of diamond drills has been left almost entirely to the drill companies, and any experimenting done at the mine in connection with diamond drilling has been confined mostly to the actual drill bits. Tests are now in progress with the object of improving both the bits and the drilling machines.

they are quenched by water. They are delivered into rack cars by a 5-ton Vaughan crane for transport to the tank house. Each car holds 32 anodes.

The Electrolytic Tank House—The tank house is a steel-frame structure 234x300 ft., with a main operating floor and basement, four tank aisles, and a central pump aisle. The tanks are serviced by three 10-ton Vaughan cranes. The basement houses the slimes-handling system and solution-circulating equipment.

In the tank house are 416 electrolytic tanks, 26 for starting-sheet production and the rest for cathode production. They are built up in nests of thirteen each of precast concrete slabs and are lined with 6 per cent antimonial sheet lead $\frac{1}{8}$ in. thick. Solution enters at the top at one end and leaves near the bottom at the other end. The discharge is designed to permit adjustment of solution level as well as to empty the tank quickly by gravity to within 8 in. of the bottom for cleaning. Anodes and cathodes are each spaced on $4\frac{3}{8}$ in. centers, the starting-sheet tanks containing 29 stripper anodes and 28 starting-sheet blanks, and the commercial tanks 32 anodes and 33 cathodes.

Tanks are arranged according to the Walker multiple system in series with the electrodes in parallel. All 416 tanks are in series in a single electrical circuit and operate normally at a current density of 14 amp./sq.ft. of cathode surface in the commercial tanks and 16 amp./sq.ft. in the starting-sheet tanks. When operating at a normal current supply of 8,750 amp. with six insoluble anode tanks in service, the total voltage drop for the circuit at the substation switchboard is 65 to 70 volts. Energy efficiency is high.

Electrolyte is circulated at a rate of four imperial gallons (18.21) per minute per tank, and its temperature is maintained at approximately 56 deg. C. by steam-coil heaters.

A lead-lined launder system collects the silver slimes and delivers them to the main basement sump, from which it is pumped to the slimes treatment plant. The concrete basement floor is acid-proofed with a 1-in. mastic coating and is drained to this same sump pump either to the slimes plant or directly to the solution storage tanks.

The Furnace Refinery—This is a steel-frame structure, 144 ft. by 181 ft. 6 in., with concrete floors, and arranged with its operating floor on two levels, and has three crane aisles and a furnace aisle. The charging aisle is equipped with a 7,000-lb. Wellman-Smith-Owen cathode-charger and a 5-ton Vaughan general-service crane. Casting and inspection aisles are each equipped with a crane.

The refining furnace is of the stationary reverberatory type with a hearth 40 ft. $8\frac{1}{2}$ in. long by 14 ft. 3 in. wide, and a metal capacity of 200 to 250 tons. It has a sprung-arch roof and an inverted-arch bottom, both of silica brick construction. The side walls are of magnesite and silica brick, the former being carried to above slag line. The furnace brickwork is carried on a massive concrete foundation, provided with ducts through which air is forced by a fan to cool the furnace bottom, the heated air serving as secondary air for combustion in the furnace. The firing end of the furnace is provided with a proper combustion chamber for pulverized coal-firing through a single burner, and natural draft is furnished by a brick-lined steel stack, 6 ft. inside diameter and 175 ft. high. Space was provided for a waste-heat boiler which has recently been installed. A line of chrome-nickel-steel heat interchanger tubes, supplied with air from the primary air fan, provides hot air for drying the coal. An electric heater installation in the duct system provides for heating this air when starting cold.

Table I—Typical Assays—1938 Operations.

	Blister Copper, %	Anodes, %	Wire Bar, %
Cu	99.3300	99.4000	99.9550
Pb	0.0029	.....	0.0004
Bi	0.0068	.....	0.0004
As	0.0006	.....	0.0001
Sb	0.0006	.....	0.0001
Sn	Nil	.....	Nil
Fe	0.0100	.....	0.0040
Zn	Trace	.....	Trace
Ni	0.0185	.....	0.0003
Co	0.0198	.....	0.0001
S	0.0265	0.0030	0.0020
Se	0.0138	.....	0.0002
Te	Trace	.....	Trace
Insol.	0.0490	.....	.....
O	0.3160	0.0300	0.0300
Cl	.....	.....	.....
H_2SO_4	.....	.....	.....
Sp. gr.	.....	.....	.....
Au, oz./ton	0.02	0.02	Trace
Ag, oz./ton	2.22	2.22	0.1160

The casting equipment consists of two electrically tilted ladles, a 38 ft. diameter Clarke-type casting wheel, together with the necessary bosh, conveyor, inspection conveyor, and auxiliary handling equipment. The wheel has roller bearings and is electrically driven through spur-gear reductions and an endless rope drive equipped with gravity take-ups for movement in both directions. It was built to the authors' designs by Markham & Company, Ltd., and is probably the first wheel of its kind to be machined as a completely assembled unit. The net result is a remarkably free-running installation taking only 5 to 10 hp. during its full cycle of operations. The wheel is designed to accommodate 30 three-pocket wirebar molds, 20 ten-pocket ingot bar molds, or the equivalent of these in any other shapes, and is suited to the production of most of the shapes demanded by the trade. At proper points in the revolution, suitable devices are provided for overturning the molds and righting them again. Accurate control of mold temperature is effected by water sprays.

The product is received by the bosh in which the cast shapes are quenched by water. The copper, as it is removed from the bosh by the conveyor, is further cooled and then delivered to the inspection conveyor.

The furnace refinery of the initial installation has a capacity at least double the daily tank-house production, so that the furnace is operated only half the time. The daily furnace charges, approximately 200 tons each, are made up of cathodes, electrolytic scrap, and any scrap or rejects from previous furnace charges.

The Electric Substation — Power from the Nkana steam plant is delivered to the refinery substation at three phase, 50 cycle, 3,300 volts. It is produced partly from waste-heat steam from the smelter reverberatories, the smelter being credited for this steam. In spite of this policy and a coal cost of about $8 per short ton, power is delivered for approximately 0.65c. per kw-hr. Power required by the various refinery departments is delivered from the substation by three-core armored cables installed underground. Two 500-kva. three-phase power transformers supply 500-volt service for motors, and two 50-kva. single-phase transformers 110 volts for lighting.

Tank-house depositing power is supplied by two motor-generator sets, one a spare. Each set consists of a synchronous motor located between and driving two d.c. generators, and an exciter overhung on one end. These sets are rated at 800 kw. each and are capable of delivering continuously a maximum of 10,000 amp. within the kilowatt range of the machine at any voltage from 5 to 100 volts. Two "Visco" 20,000 cu.ft./min. air washers, one a spare, deliver conditioned air into the basement, from which it rises through the motor-generator sets, keeping them cool and maintaining a low ambient temperature in the generator room at all seasons.

The Slimes Plant — The treatment building is a steel-frame structure, 32 by 54 ft. It is arranged with two operating floors, the upper being of heavy timber construction, and the lower of reinforced concrete covered with a layer of asphalt mastic 1 in. (2.5 cm.) thick. The upper floor carries the slimes storage-decanting tanks, and the filtration and drying equipment are conveniently arranged on the lower floor, together with the oxidizer equipment used in making up the initial electrolyte.

The silver slimes, after being filtered and dried, are returned to the smelter, where they are melted up in special lots of blister shipped to Europe for refining. About two tons of slimes, containing approximately 5 oz. (155.5 g.) of gold and 600 oz. (18.662 kg.) of silver per ton, result from the production of 1,000 tons of cathodes.

Some Studies on

The Gold-Dissolution Rate In Cyanide Solutions

An investigation of the effect of certain variables

A. W. Fahrenwald* . . . and . . . Joseph Newton

Professor of Metallurgy — *Assistant Professor of Metallurgy*

School of Mines, University of Idaho, Moscow, Idaho

ACCORDING to the researches of Barsky, Swainson, and Hedley,[1] it appears that the equations which probably represent the chemical action of oxygenated cyanide solutions upon metallic gold are those of Bodlaender:

$$2\ Au + 4\ CN^- + 2H_2O + O_2 \rightarrow 2\ Au(CN)_2^- + H_2O_2 + 2OH^-$$

$$2\ Au + 4\ CN^- + H_2O_2 \rightarrow 2\ Au(CN)_2^- + 2\ OH^-$$

When these two are added, the intermediate substance H_2O_2 does not appear in the final equation, and we have Elsner's equation:

$$4\ Au + 8\ CN^- + 2H_2O + O_2 \rightarrow 4\ Au(CN)_2^- + 4\ OH^-$$

$$4\ Au + 8\ NaCN + 2H_2O + O_2 \rightarrow 4\ NaAu(CN)_2 + NaOH$$

In addition to the cyanide and oxygen contained in solution, there is always present an alkali (usually lime) to prevent the decomposition of cyanide. It has been shown by a number of experimenters that the rate at which gold will dissolve in a cyanide solution depends on (1) the cyanide content of the solution, (2) the oxygen content of the solution, and (3) the concentration and chemical nature of the alkali used. Much work has been done on this problem, but no adequate theory which completely explains all the observed effects has been formulated.

As a contribution to this study of the rate of dissolution of gold in cyanide solutions, the following experimental data are presented. Three studies were undertaken, which will be discussed in turn: (1) the effect of simultaneous variation of cyanide and oxygen content on the dissolution of gold from gold foil, (2) the effect of varying oxygen pressure on the dissolution of gold from a siliceous gold ore, and (3) the effect of various alkalies on the rate of dissolution of gold from a siliceous ore.

The Experiments

Part 1—It has been shown[2] that the rate of dissolution of gold in a cyanide solution of constant oxygen content increases with the cyanide concentration for low cyanide concentrations, but reaches a maximum and then decreases for higher concentrations of cyanide. Beyers[3] has shown that under certain conditions the rate of dissolution of gold in solutions of constant cyanide strength decreases as the oxygen content increases. Inasmuch as gold will not dissolve in oxygen-free solutions, it seems probable that the rate of dissolution would increase, reach a maximum, and then decrease again as the oxygen content increased in a solution of constant cyanide content. This effect would be analogous to that found in solutions of varying cyanide content and constant oxygen content mentioned previously.

White[4] suggests that, since both cyanide and oxygen molecules must appear at the gold surface in the ratio called for by Elsner's equation, the rate of dissolution should be governed by the rates of diffusion of these two species of molecules. If conditions were such that molecules of cyanide and oxygen appeared at the gold surface in exactly the right proportions, the dissolution rate would have a certain figure, and this rate would diminish if the "rate of supply" of either the cyanide or oxygen were to diminish. The rate at which the molecules of any particular species would arrive at the surface would depend on both the specific diffusion constant of the species in question and its concentration in the solution.

Consideration of the items cited in the foregoing led to the supposition that if the cyanide content and oxygen concentration (pressure) were increased simultaneously in a constant ratio, the rate of dissolution of the gold should be directly proportional to the oxygen pressure (also to the cyanide content). The experiments in the first set of tests were designed to test this hypothesis, and the data are presented in Fig. 1.

The gold used was in the form of 24-carat foil, about 0.08 in. thick, and the individual samples were cut in the forms of small isosceles right triangles measuring 1 cm. on the hypotenuse. The dissolution chamber was a paraffin-lined steel cylinder with a removable end, equipped with a valve so that air or oxygen could be introduced under pressure. The gold foil was suspended from a paraffin-covered cork float so that the gold triangle was immersed in the potassium-cyanide solution at all times.

In making a test, the solution (700 c.c.) was placed in the cylinder, the float and weighed triangle were inserted, and the end of the cylinder was bolted on. The desired amount of air or oxygen was then admitted under pressure, and the cylinder was mounted

* Laboratory contributions by Richard G. Courtney and James H. Maguire, graduate students, 1937-38, School of Mines, University of Idaho.

on rolls which kept it rotating slowly (6 r.p.m.) for the duration of the test. At the end of the test, the gold triangle was removed, washed, and weighed, and the gold loss calculated by difference. The solution was titrated for cyanide before and after each test.

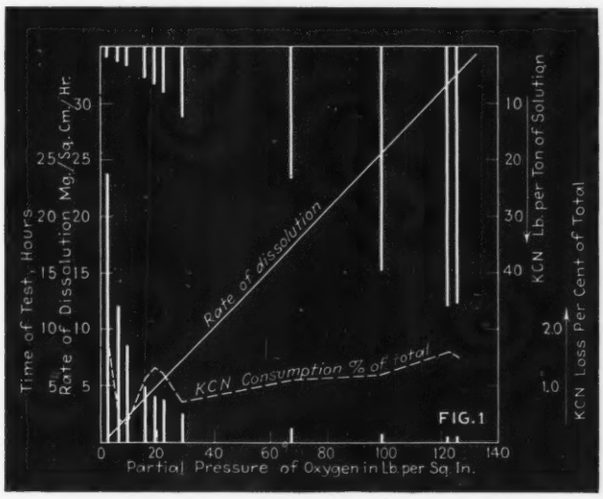
For low pressures, air alone was used, but at higher pressures a mixture of air and oxygen was employed. The pressures were all calculated to give the partial pressure of oxygen in pounds per square inch. No alkali was added to the cyanide solution in any of the tests on gold foil. The cyanide content increased from about 1 lb. per ton to over 45 lb. per ton and the partial pressure of oxygen increased from about 3 lb. per square inch to over 120 lb. per square inch.

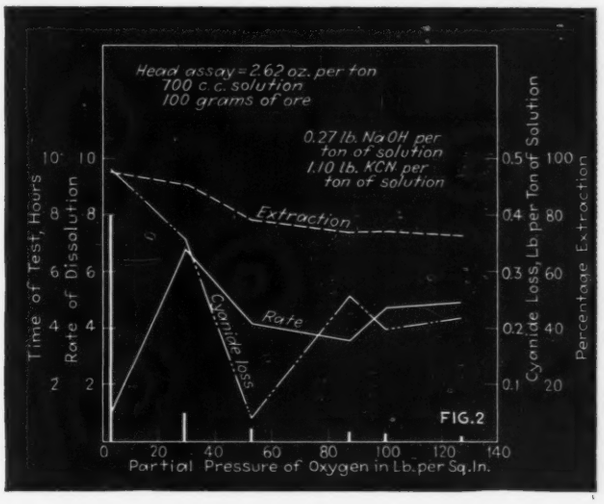
The rate of dissolution is expressed as the number of milligrams of gold dissolved per hour from 1 sq. cm. of the surface. This was calculated in each case from the loss in weight and the measured dimensions of the gold triangle. To keep conditions as nearly as possible the same for all cases, the tests at high pressures were run for a shorter period of time than the tests at low pressures, and the time was regulated so that in each test about the same weight of gold was dissolved.

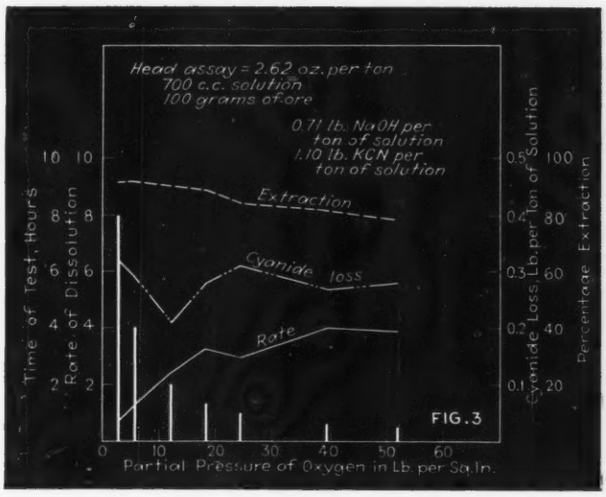
Fig. 1 shows that, under the conditions outlined in the preceding discussion, the rate of dissolution is directly proportional to the oxygen pressure; the experimental points lined up almost exactly along a straight line. The broken line indicates the cyanide loss expressed as per cent of the initial amount. Heavy vertical lines indicate the pressures at which the individual tests were made; the lengths of the lines extending up from the bottom are proportional to the time of the test in hours; the lengths of the lines extending down from the top are proportional to the KCN content of the solution in pounds per ton.

Experiments: Part 2—These tests were made to determine the effect of varying oxygen pressure on the dissolution of gold from a siliceous ore by a solution of constant cyanide strength. Three sets of tests were made, and the data are presented in Figs. 2, 3 and 4. Cyanide and alkali content used are indicated on the figures. Rate of dissolution, cyanide loss, and total extraction are shown by curves, and the lengths of the heavy vertical lines are proportional to the time allowed for the individual tests.

Apparatus and procedure were essentially the same as those employed in measuring the dissolution rate of the gold foil. The ore assayed 2.62 oz. of gold per ton and 0.5 oz. silver; it consisted principally of silica with small amounts of iron oxide and sulphides. The ore was ground in batches for 30 minutes in a laboratory ball mill and thoroughly mixed. Samples for individual tests were then weighed


Time of Test, Hours
Rate of Dissolution, Mg./Sq. Cm./Hr.
KCN Lb. per Ton of Solution
KCN Loss Per Cent of Total
Rate of dissolution
KCN Consumption % of total
FIG.1
Partial Pressure of Oxygen in Lb. per Sq. In.


Head assay = 2.62 oz. per ton
700 c. c. solution
100 grams of ore
0.27 lb. NaOH per ton of solution
1.10 lb. KCN per ton of solution
Extraction
Rate
Cyanide loss
Time of Test, Hours
Rate of Dissolution
Cyanide Loss, Lb. per Ton of Solution
Percentage Extraction
FIG.2
Partial Pressure of Oxygen in Lb. per Sq. In.


Head assay = 2.62 oz. per ton
700 c.c. solution
100 grams of ore
0.71 lb. NaOH per ton of solution
1.10 lb. KCN per ton of solution
Extraction
Cyanide loss
Rate
Time of Test, Hours
Rate of Dissolution
Cyanide Loss, Lb. per Ton of Solution
Percentage Extraction
FIG.3
Partial Pressure of Oxygen in Lb. per Sq. In.

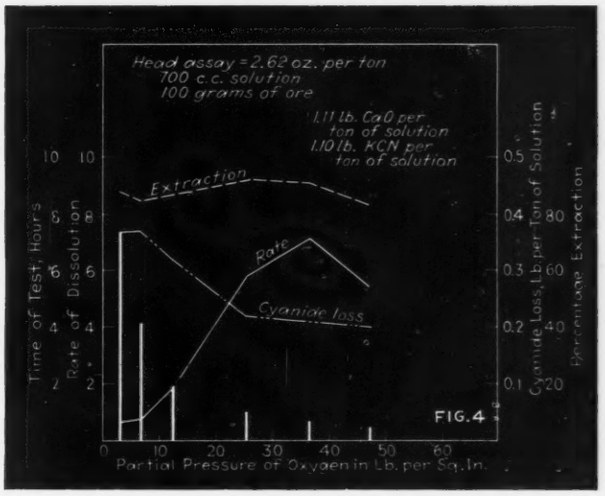

Head assay = 2.62 oz. per ton
700 c.c. solution
100 grams of ore
1.11 lb. CaO per ton of solution
1.10 lb. KCN per ton of solution
Extraction
Rate
Cyanide loss
Time of Test, Hours
Rate of Dissolution
Cyanide Loss, Lb. per Ton of Solution
Percentage Extraction
FIG.4
Partial Pressure of Oxygen in Lb. per Sq. In.

Fig. 1 . . . THE RATE of dissolution of gold foil in cyanide solution, for the conditions prevailing during Part I of the experiments, is here shown to be directly proportional to the oxygen pressure. Other details are explained in the text. Figs. 2, 3, and 4 . . . GRAPHS plotted from data obtained in three sets of tests, respectively, conducted to determine the effect of varying oxygen pressure on the dissolution of gold from a siliceous ore by a solution of constant cyanide strength

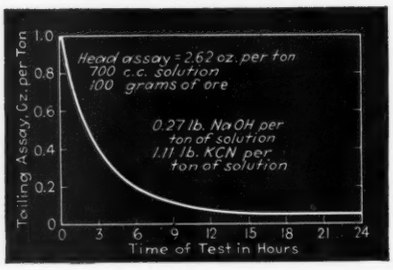

Head assay = 2.62 oz. per ton
700 c.c. solution
100 grams of ore
0.27 lb. NaOH per ton of solution
1.11 lb. KCN per ton of solution
Tailing Assay, Oz. per Ton
Time of Test in Hours

Fig. 5 . . . PRELIMINARY TESTS, made at the outset of the experiments in Part 2, to determine the rate of dissolution of gold from a siliceous ore at atmospheric pressure by a cyanide solution of constant strength, gave the data plotted here

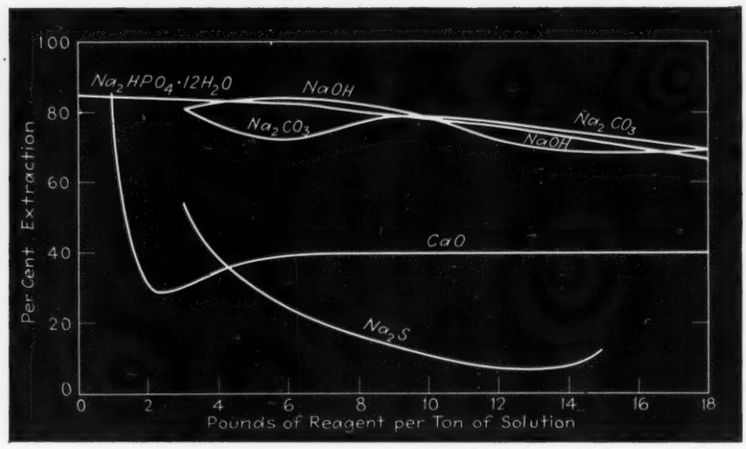


Fig. 6 . . . THE PERCENTAGE EXTRACTION of gold from a siliceous ore containing a small amount of sulphides obtained in Part 3 of the experiments is given here for various alkali reagents. The amount and type of these reagents were the only variables

out as needed. In each of the tests, 100 grams of ore were used and 700 c.c. of solution.

As a preliminary, a number of tests were made at atmospheric pressure, and data thus evolved gave the curve shown in Fig. 5. The tailing assay drops off quite rapidly for the first hour or two of agitation, but after that the curve levels off and the rate of dissolution becomes quite low toward the end of the longer runs. Because of the rapidity at which the rate of dissolution changes, it was not expedient to measure the rate of dissolution in milligrams of gold dissolved per unit of time for the subsequent tests (as was done in the case of the gold foil). Accordingly, the curve in Fig. 5 was assumed to give a "standard" rate of dissolution, and the "rate of dissolution," as given in Figs. 2, 3, and 4, is computed from it as follows:

In each test, the tailing was removed, washed, and assayed. From Fig. 5 then was read the time that it would have taken to reduce the tailing assay to this amount under atmospheric pressure. This time divided by the actual time of the test gave a number which was called the dissolution rate. For example, in Test 36, at an oxygen partial pressure of 52 lb. per square inch, the time of agitation was 0.5 hr. and the tailing assay 0.56 oz. per ton. The time required to obtain this assay under atmospheric pressure (Fig. 5) was 2.00 hr. Hence, the rate of dissolution was

$$\frac{2.00}{0.50} = 4$$

In other words, a dissolution rate of 4 means that, under the conditions of the test, a given tailing assay was produced in one-fourth the time it would have taken under atmospheric pressure.

Experiments: Part 3—The ore used for this set of tests was also a siliceous ore containing a small amount of sulphides; the head assay was 0.59 oz. of gold and 0.7 oz. of silver per ton. The only variable was the type and amount of alkali used. Conditions under which these tests were made were as follows:

(1) Pulp agitated for 3 hr. (2) 100 grams of ore and 200 c.c. of solution used. (3) agitation performed in open glass bottles placed on bottle rolls. (4) Constant cyanide (NaCN) content of 6.054 lb. per ton of solution used in all tests.

Percentage extraction for each of the reagents used is shown in Fig. 6. The pH cyanide loss for each test is found in Tables I and II.

Lime used was weighed out dry and added to the pulp. The amount used in some of the tests exceeded the solubility of lime in the amount of water used, so that these tests utilized a saturated lime solution plus some solid lime in excess.

Discussion—It is difficult to draw definite conclusions from the work done to date, largely because of the fact that the actions of many of these variables are interrelated. Following are a few observations on the data shown by the curves and the tables:

1. The rate of dissolution of gold from a sheet of foil is directly proportional to the pressure of oxygen (Fig. 1), provided the cyanide strength of the solution is increased in the same ratio as the oxygen pressure. This would appear to agree with the hypothesis that, all other things being equal, it is the rate at which cyanide and oxygen molecules (in the ratio required by Elsner's equation) are supplied to the gold surface that determines the rate at which the gold will corrode. This observation applies to solutions containing only cyanide and oxygen. It is possible that the addition of other substances to the solution might cause the curve to deviate from a straight line, and an investigation of this sort might throw some light on the unexplained effects of certain salts and bases on the rate of dissolution of gold in cyanide solution.

2. Figs. 2, 3, and 4 show that the rate of dissolution of gold from an ore does not increase in proportion to the oxygen pressure in solutions of constant cyanide strength; rather it tends to increase rapidly at first, reach a maximum, and then diminish again. This behavior apparently is in accord with the phenomena observed in Part 1. The data are not complete enough to speculate upon the reasons for the difference in the three curves (Figs. 2, 3, and 4) caused by the differences in the type and amount of alkali. Rate of dissolution follows the same general trend in all cases, however.

3. The curves in Figs. 1, 2, 3 and 4 show that as a rule the cyanide loss tends to decrease at first and then rises again. It is probable that a part of the cyanide loss is due to oxidation, and that the initial drop is caused by the fact that the time of agitation decreases rapidly and the cyanide is not exposed to the oxidizing action for so long. At the other end of the curves, however, the relative change in time of agitation is not so great, and the con-

TABLE I—pH of Solutions in Tests Made in Experiment 3

Reagent	Concentration in Pounds Per Ton of Solution 1	2	3	6	9	12	15	18
$Na_2HPO_4.12H_2O$	....	....	10.4	10.4	10.4	10.4	10.4	9.9
Na_2CO_3	....	....	9.8	9.8	9.8	9.8	9.6	9.6
CaO	12.0	12.2	12.4	12.4	12.6	12.6	12.6	12.6
Na_2S	....	....	12.0	....	....	....	12.8	....
NaOH	....	....	12.0	12.6	12.7	12.7	12.7	13.1

TABLE II—NaCN Consumption in Tests Made in Experiment 3

Pounds Per Ton of Solution

Reagent	Concentration in Pounds Per Ton of Solution 1	2	3	6	9	12	15	18
$Na_2HPO_4.12H_2O$	....	....	1.184	1.104	1.134	1.104	1.104	1.184
Na_2CO_3	....	....	1.334	1.654	1.754	2.034	2.494	1.414
CaO	0.674	0.634	0.354	0.334	0.354	0.354	0.234	0.234
Na_2S	....	....	2.794	....	2.054	....	....	....
NaOH	....	....	0.234	0.134	0.134	0.094	0.554	0.474

Electric Smelting With the Westly Furnace

In connection with methods for utilizing SO_2 gas it can now be built to handle 300 tons and more of solid charge per day

M. Sem
Oslo, Norway

DURING THE WAR recommendations were made by various metallurgists that electric smelting should be used for the production of copper. In the United States, Messrs. Lyon and Keeney and Prof. J. W. Richards were seriously interested in the proposal. Another pioneer was Professor Borchers, at Aachen, Germany. The practical application of the idea also dates from this period, when Jens Westly, an engineer of A/S. Sulitjelma Gruber, in Norway, developed the so-called Westly furnace. Through these tests the economy of the method was ascertained under the conditions existing at Sulitjelma. This early work was reported in considerable detail in *Engineering and Mining Journal*, p. 356 (1922), to which the reader is referred. The accompanying line drawing (Fig. 1) shows sections through this early furnace, which was operated with prebaked electrodes. There were actually six small electrodes arranged in line in a long furnace with a matte sump at one end.

The results were promising, but the furnace was shut down during the post-War depression, owing to the low price of copper. It was not until 1928, when the present Sulitjelma furnace was built, that the method was adopted on a large scale.

The new Sulitjelma furnace is of about 2,500-kva. capacity. It was designed by Mr. Westly in cooperation with Det norske Aktieselskab for Elektrokemisk Industri (Elektrokemisk), at Oslo, Norway, and based on the use of Söderberg electrodes. It is a three-phase furnace provided with mechanical charging, as shown in Fig. 2, which gives a view of the furnace platform. The furnace has proved reliable, having operated continuously without shutdown for about five years. A flotation concentrate containing about 20 per cent copper is smelted, yielding a matte. This matte is blown to blister copper in a bessemer converter. The yearly production amounts to 5,000 to 6,000 tons of copper 99.15 per cent pure.

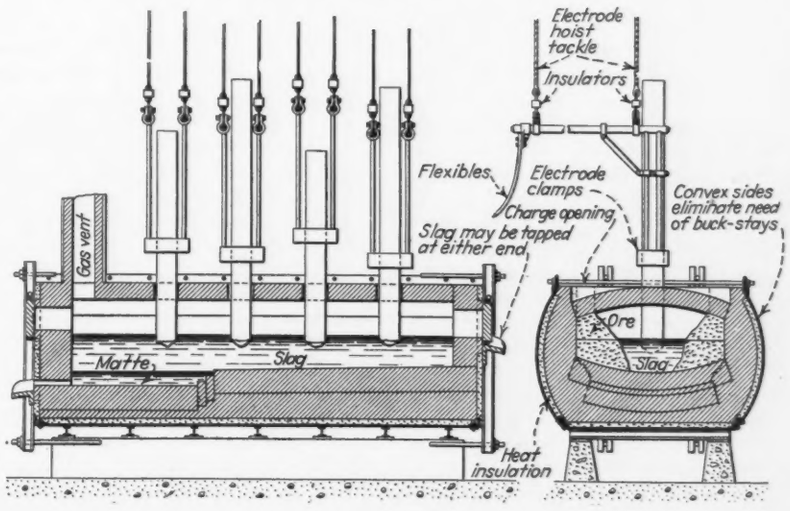
Results obtained by this method will be dealt with more fully in connection with the Finnish furnace later.

One reason the introduction of the method advanced so slowly was partly because of the improvements made on the reverberatory furnace (such as the use of waste-heat boilers and the preheating of air); another reason was, however, that the first electric furnaces were of a relatively small capacity, so that many of them were necessary in order to take over the work of one large reverberatory furnace. During recent years, however, two developments have taken place which seem to change the situation, namely:

1. Knowledge as to building large electric smelting furnaces has increased materially, so that such furnaces can now be built of a capacity comparable with that of the reverberatory furnaces.

2. The new methods that have lately been developed for utilization of SO_2 in smelter gases have made it desirable—in many cases even necessary—to utilize the gases. The economic possibility is, however, to a great extent dependent on the concentration of SO_2 in the gases. A high concentration in the gas is possible only in an electric smelting furnace where the gas is not diluted with gases of combustion.

FIG. 1 . . . DIAGRAMMATIC SKETCH of the early Westly electric smelting furnace in operation



centration of oxygen is increasing rapidly, so that there is more oxidation of the cyanide.

4. Examination of Fig. 6 and Tables I and II shows that the effects of NaOH, Na_2CO_3, and $Na_2HPO_4.12H_2O$ on the extraction are all about the same. However, CaO and Na_2S decrease the rate of dissolution very markedly. Two facts are brought out by the results of these short-time tests in strong cyanide solution, namely:

a. Alkalinity (pH) cannot be the principal factor causing the decrease in solution rate, or there should be expected a marked difference in the curves for NaOH, Na_2CO_3, and $Na_2HPO_4.12H_2O$, since there is considerable difference in the pH of these solutions (Table I).

b. Cyanide loss and rate of dissolution are not directly connected, because both Na_2S and CaO strongly inhibit the dissolution of gold, but the cyanide loss in the case of Na_2S is much greater than in the case of CaO. Likewise, there is a great difference in the cyanide losses in solutions of NaOH and Na_2CO_3, but these two reagents have about the same effect on the rate of dissolution.

1 Barsky, George, Swainson, S. J., and Hedley, Norman: "Dissolution of Gold and Silver in Cyanide Solutions." *Trans.* A.I.M.E. Vol. 112, p. 660 (1934).

2 Barsky, et al., *op cit.*

3 Beyers, Ernst: "Some of the Factors Which Influence the Rates of Dissolution of Gold and Silver in Cyanide Solutions." *Jour. of the Chem., Met., and Min. Soc. of South Africa*, Vol. XXXVII, No. 2, August (1936).

4 White, H. A.: "The Physics of Gold-solution." *Jour. of the Chem. Met., and Min. Soc. of South Africa*, Vol. XXXV, No. 1, July (1934).

These were decisive facts for the Outokumpu Oy., the large producer of copper in Finland, when the company determined in 1934 to erect a smelting works at Imatra for smelting copper concentrate, which product had previously been exported to Germany. The aforesaid Norwegian company (Elektrokemisk Industri, at Oslo), was then given the interesting task (in cooperation with Mr. Westly) of designing the largest closed electric smelting furnace in the world. The furnace was put in operation at the beginning of 1936, and is now smelting 240 to 250 tons of cold charge per day. Power consumption varies between 500 and 600 kw.-hr., according to the ore used and other circumstances. Electrode consumption is generally between 2 and 3 kg. electrodes per ton.

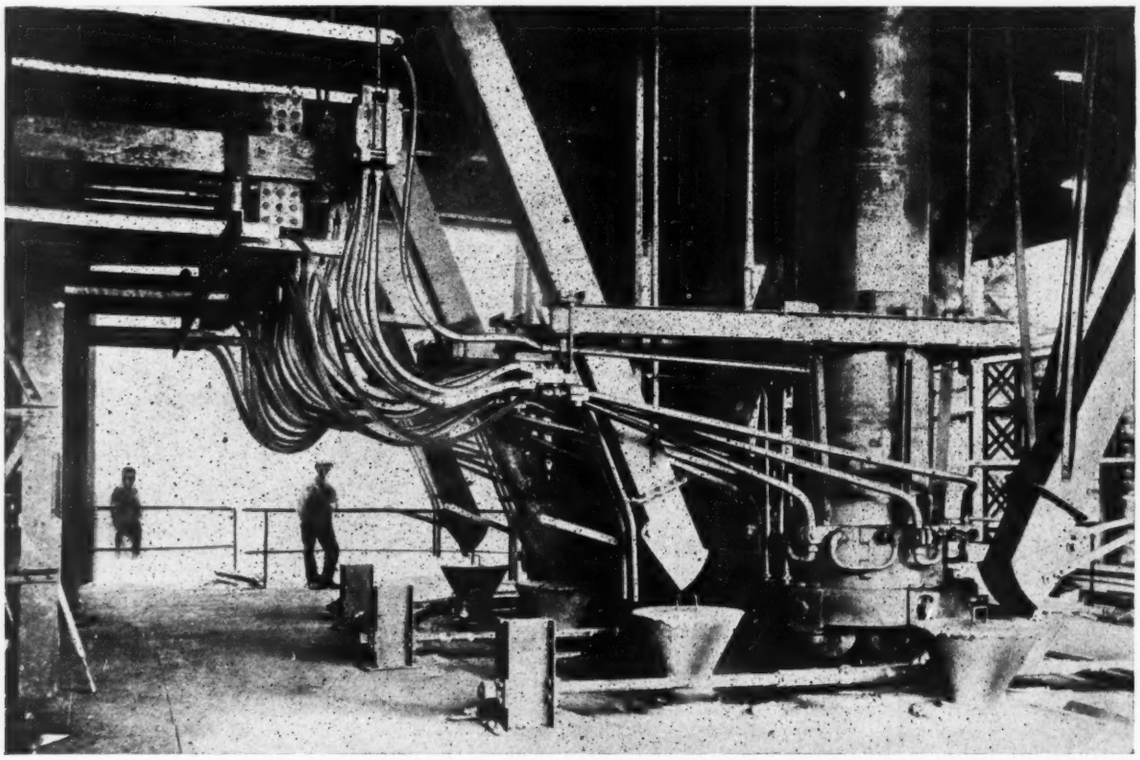


Fig. 2 . . . THE SULITJELMA FURNACE, with Solderberg electrodes. It is a 3-phase furnace and of 2,500-kva. capacity.

The slag contains about 0.3 to 0.6 per cent copper, depending on the concentration of copper in the matte. The raw material is a copper concentrate containing about 20 per cent copper. Part of the concentrate is roasted. The roasted part is mixed with a corresponding part of raw concentrate and is smelted with necessary "flux," so that ordinarily a matte containing about 50 per cent copper is obtained. From this matte is produced a-blister copper by bessemerizing. The iron is partly oxidized and slagged off in the electric furnace and partly in the converter. Converter slag is returned in liquid form to the electric furnace, where it serves as a flux.

The outside diameter of the furnace is about 10 meters. The three Soderberg electrodes are each of 1.4 meter diameter, weighing approximately 15 tons. Mechanical charging from overhead hoppers has been provided. The magnesite lining of the furnace carries separate tapping holes for slag and matte. Slag may flow continuously, whereas the matte is tapped into a ladle through water-cooled tapping holes.

The gas from the furnace is mixed with the gas from the bessemer converters, and is thoroughly cleaned from its content of SO_2 before it escapes through the 120-meter high stack. Cleaning is effected in a scrubber, according to the method of the Imperial Chemical Industries, Ltd. The gas is washed with a solution of basic aluminium sulphate, whereby a quantity of up to 70 grams of SO_2 per liter is absorbed by the solution. From this solution a pure SO_2 gas is then produced by heating to about 100 deg. C. Thereby nearly pure SO_2 gas is driven off, which, after being dried, is compressed in tank wagons and conveyed to cellulose factories in liquid condition. They use it for production of sulphite cellulose.

Besides the process of the I.C.I., there now exist several other processes for production of conentracted SO_2 or elementary sulphur from gases. Thus, a plant employing the Lurgi Sulfidine process is now in commercial operation in the north of France.

In the design of the Imatra furnace no special attention was paid to making the furnace gas-tight. Therefore, a considerable excess of air is used. This naturally reduces the concentration of SO_2 in the gas. With the experience now on hand, no considerable difficulty is involved in closing the furnace gas-tight, and thereby arriving at the direct production of concentrated gas. This seems of great importance for the economy of the collection of the gas.

In the processes mentioned in the foregoing it is necessary to concentrate the SO_2 before it can be utilized. When the furnace gas itself is collected at a concentration of at least 10 to 20 per cent SO_2 the concentration process may be avoided with corresponding savings in the operating costs. In the process used at Boliden, in the north of Sweden, such gas is reduced direct without concentration for the recovery of elemental sulphur.

The electric smelting furnace in connection with the methods mentioned for utilization of SO_2 gas has now good chances of more extensive adoption within the metallurgical industry, where smelter smoke is such an important issue. The new type of furnace can be built, it is said, in sizes up to 300 tons or more of solid charge per day.

As a summary, the advantages of the electric smelting can be stated as follows: The sulphur can be recovered economically; power and electrode consumption are reasonable; loss in slag and dust is low; and operation is simple and reliable.

Open-Pit Transport—IV

Steam Haulage Versus Electric Haulage

The Cost of Power

L. C. Moore
Mechanical Engineer
Hibbing, Minn.

THE amount of electric power needed for haulage was calculated for runs from various shovel locations and is indicated for one of them in Table IV for ore haulage and in Table V for stripping. The calculations were based on a tractive effort requirement of 20 lb. per ton of train weight for each 1 per cent of grade, 0.8 lb. per ton for each 1 deg. of curvature, and 8.0 lb. per ton for train friction in ore haulage and 10 lb. per ton for friction in stripping haulage. Lower values of friction may be substantiated under specified operating condition on good track, and higher values under adverse operating conditions such as may exist on temporary track. However, for the purpose of this report, the values given in the foregoing are chosen as being reasonably good average values. The time of run has been calculated from the locomotive speed-tractive effort curve, included in the locomotive specifications, using speeds corresponding to various calculated tractive efforts.

Estimated annual power requirements for ore and stripping haulage are shown in Tables VII and VII-A respectively. The power for ore haulage has been arbitrarily divided into five equal monthly periods and stripping power into four monthly periods and these values assigned to the various months, under kilowatt-hours, in Table X, item (e).

In determining cost of power, Minnesota Power & Light Company P-6 schedule is used. This schedule permits combination of other power with haulage power in open-pit mining operations. This usually results in a more favorable power rate and, therefore, since considerable power is used for electric shovels, washing plant, water pumping, and complementary operations, advantage is taken of this provision in estimating the additional cost of power for haulage.

Power for the washing plant, as shown in Table VIII, was estimated by taking actual power consumed in the 1930-31 season for production of 657,638 long tons of concentrate and extending it to cover 700,000 long tons of concentrate, the amount now under consideration. This was divided into monthly periods and entered by months, under kilowatt-hours, in Table X, item (a).

Pit power, which included power for shovels, pit pumping, and similar work was estimated in part from actual consumption in 1930-31 and in part by using for shovel power a flat figure of 0.22 kw-hr. per ton of ore and 0.40 kw.-hr per yard of stripping, the details of this estimate being shown in Table IX. The power was allocated to various months and entered under kilowatt-hours in Table X, items (b) and (c).

Estimates of peak power—i.e. contract horsepower, according to M.P. & L. Co.'s P-6 schedule, for hauling ore and stripping, was estimated in Tables VII and VII-A on the basis that in each case the maximum 30-minute peak would be established when two loaded trains completed their run from shovel to washing plant, or stripping dump, inside of a 30-min. period. These values have been entered in Table No. X, item (i). The contract horsepower for the washing plant was estimated on the basis of using actual average figures for the six months 1930-31 ore season as shown in Table VIII, and prorating to the increased production and to the assumed five-month ore season covered in this report. The contract horsepower for the pit, including shovels, was based on actual figures obtained during the 1930-31 season as shown in Table IX. These estimates are entered in Table X, items (g) and (h) respectively.

The contract horsepower which will obtain when the various services are combined will not necessarily be the sum of the individual contract horsepowers. It is quite improbable, for example, to have a maximum peak on the shovels when a peak is occurring in haulage, for the reason that under this condition most of the cars are in transit and the shovels will have only a limited number of empty cars to load. Similarly, a washing plant peak would not come at the same time as a shovel peak. The estimated combined contract horsepower for washing plant, shovel, pumping, and related operations exclusive of haulage, is shown in Table X, item (j), and for the total including haulage in item (k). These estimates are somewhat arbitrary, but in general have been based on the maximum which would be obtained by adding an individual contract horsepower to approximately 70 to 80 per cent of the average horsepower of the remaining power load.

Based on 720 hours' use per month of the contract horsepower thus obtained, the monthly load factors vary from approximately 29.4 to 47.4 per cent for washing plant, shovel, and pit power, and from 29.4 to 54.3 per cent when haulage power is included.

The cost of power was calculated by the method outlined in M.P.&L. Co's. P-6 schedule, using the monthly kilowatt-hour and contract horsepower in items (d) and (j), Table X, to obtain cost of power exclusive of haulage, and the monthly kilowatt-hour and contract horsepower in Items (f) and (k), Table X, to obtain cost of all power including haulage. Thus:

Estimated annual cost of power for washing plant, shovels, pit and haulage	$60,587
Estimated annual cost of power for washing plant, shovels, and pit (no haulage)	47,227
Estimated cost of power for haulage	$13,360

In making these calculations the "Steam Operation Adjustment" and "Power Factor" clauses of the P-6 schedule were not taken into consideration.

It should be pointed out that different assumptions with respect to contract horsepower will change the cost of power somewhat; however, it is anticipated that a different assumption

Table VII—Haulage Power in Ore Haulage

(a)	Kw. hr. per round trip from shovel location No. 1	188.4
(b)	Kw. hr. per round trip from shovel location No. 2	193.7
(c)	Kw. hr. per round trip from shovel location No. 3	170.1
(d)	Kw. hr. per round trip from shovel location No. 4	171.2
(e)	Ave. kw. hr. per round trip, at substation direct current bus.	180.9
(f)	Ave. kw. hr. per round trip at high tension side of substation transformers (e ÷ average over-all substation efficiency of 0.915)	198
(g)	Ave. kw. hr. per round trip at metering point = 95% of "f" (according to Minnesota Power & Light Co's P-6 schedule).	188
(h)	Long ton of ore per round trip	220
(i)	Kw. hr. at metering point per long ton ore (g ÷ h)	0.855
(j)	Total long tons ore	1,050,000
k)	Total kw. hr. at metering point for ore haulage (j x i)	897,500
(l)	Assumed number of months in ore haulage season (basis 120 working days at 24 per month)	5
(m)	Total kw. hr. for ore haulage per month (for 5 mos.)	179,500
(n)	Total hours of substation running on basis of 120 working days of 2 8-hour shifts each (120x2x8)	1,920
(o)	Average kw. at metering point on ave. 8-hour shift of 4375 long tons (k ÷ n)	468
(p)	Average kw. hr. at metering point on max. day of 5,000 long tons in 8 hours	535
(q)	Maximum 30-min. peak at metering point based on 2 loaded trains completing run from shovel to crusher inside ½-hour period (gx2x60/30)	752
(r)	Actual horsepower at metering point (q ÷ 0.746)	1,010
(s)	Contract horsepower (according MP&L Co's P-6 schedule = r — 25%)	760

Note: See Table X for summation of all power.

Table VII-A—Haulage Power in Stripping

(a)	Kw. hr. per round trip at substation d. c. bus	114
(b)	Ave. kw. hr. per round trip at high-tension side of substation transformers (a ÷ average over-all substation efficiency of 0.89)	128
(c)	Ave. kw. hr. per round trip at metering point = 95% of (b) (according to MP&L Co's P-6 schedule)	122
(d)	Cubic yards of stripping per round trip	156
(e)	Kw. hr. at metering point per cubic yard stripping (c ÷ d)	0.784
(f)	Total yards stripping	500,000
(g)	Total kw. hr. at metering point for stripping haulage (fxe)	392,000
(h)	Assumed number of months in stripping season (basis 80 working days at 20 per month)	4
(i)	Total kw. hr. for stripping per month (for 4 mos.)	98,000
(j)	Total hours of substation running on basis of 80 working days of 2 8-hour shifts each (80x2x8)	1,280
(k)	Average kw. at metering point on average 8-hour shift of 3,125 yd. (g ÷ j)	306
(l)	Maximum 30-min. peak at metering point based on 2 loaded trains completing run from shovel to stripping dump inside ½-hour period (ax2x60/30)	488
(m)	Actual horsepower at metering point (1 ÷ 0.746)	655
(n)	Contract horsepower (according to MP&L Co's P-6 schedule= m — 25%)	490

Note: See Table X for summation of all power.

Total kw. hr. for ore haulage (Item K, Table VII)	897,500
Total kw. hr. for stripping haulage (Item G, Table VII-A)	392,000
Total kw. hr. for haulage	1,289,500

will not change the estimated cost of power for haulage alone enough to materially affect the comparison between steam and electric haulage.

Distribution System—The trackage to be electrified as determined from the maps is approximately as follows: total permanent track, 47,200 ft., total temporary track, 16,500 ft., total all tracks, approximately, 63,700 ft., or 12.05 miles.

A "side-arm" type of distribution system considered suitable for the proposed electrification consists of an overhead contact wire hung in simple suspension from pole brackets about 18 ft. above the top of rails and about 9 ft. from the center of track. This type of construction will provide suitable clearance for the shovel dippers at loading points where it may be necessary for the electrified track to run past the shovel. (On dead-ended track a locomotive cable reel may be used instead of overhead contact wire, if desired). It also leaves the track free of overhead obstructions, except at some of the crossovers or switchback points, so that a wrecker crane or other large equipment can be moved or operated with greater facility. The electric locomotives are equipped with two-side arm pantographs, one on each side, so that power may be collected from whichever side of the track is best suited for installation of the contact wire. This type of construction is less expensive than the catenary type, which is usually required for the heavier and faster locomotives, and is therefore more readily justified from an economic standpoint, particularly as the mine is estimated to have only a 12-year life.

From an economic standpoint it is better to have a single substation, provided the distribution system can be laid out without requiring an excessive amount of copper to give a reasonable voltage drop. Fortunately, in this case the layout of the track, length of haul, weight of trains, and related factors are such that this can be readily accomplished. If a single-unit substation is installed alongside the main line track where the shop track joins in (see Fig. 3) and if a 750-volt d.c. distribution system is assumed, the copper required to give approximately 90 per cent distribution efficiency will be as follows: 80,700 ft., add 5 per cent for sag, waste, etc., 4,000 ft., total copper (equivalent No. 4/0, 84,700 ft.; total weight at 640.5 lb per 1,000 ft., 54,250 lb.

All poles on permanent track are assumed to be set in the ground and suitably guyed or braced where needed. All poles on temporary track are assumed to be portable type with bases which can be weighted down with rocks to provide stability.

The estimate which follows includes six cable-reel connectors, of which four are assigned to various shovel locations in ore and two to shovel locations in stripping. It also includes ten manually operated sectionalizing switches which are for the purpose of disconnecting the various leads to the shovels, both ore and stripping, and the tracks on the stripping dumps, and for cutting out the shop tracks as needed, so that if trouble should appear in any of these sections, or it should be necessary to make adjustments in the contact wire, the section in question can be isolated from the rest of the system.

The estimated total cost of distribution system is given in Table XI. It is approximately $5,000 per single-track mile.

The Substation

A detailed study of the power consumption discloses that the substation serving the locomotives will have to be capable of supplying power approximately as follows:

Average substation output at d.c. bus based on 1,050,000 long tons of ore	
180.9 kw.-hr. at substation d.c. bus per round trip	
220 long tons ore per train	
240 8-hr. shifts, or a total of 1,920 hours	
4,375 long tons of ore on average per 8-hr. shift $(\frac{1,050,000}{220} \times 180.9) \div 1,920 =$	450 kw.
Average substation output at d.c. bus on maximum day of 5,000 long tons 450 x (5,000/4,375)	514 kw.
Maximum 30-min. output based on two trains completing their run to the shovel inside a 30-min. period (180.9x2) ÷ 1/2 hr	725 kw.
Maximum momentary peak based on two trains accelerating simultaneously at 25 per cent adhesion, approximately	1,600 kw.

To do this a single-unit substation having a capacity of 750 kw. continuously, 1,125 kw. for two hours, and 2,250 kw. for one minute, was selected. This capacity is somewhat more than is needed to meet the requirements, but the next smaller standard size of 500-kw. capacity would be too small to take the short-time peak. A capacity of 750 kw., however, meets all requirements and provides a reasonable, but not an excessive, margin of safety, and also provides margin for additional demands as the pit grows deeper.

As stated under "Distributing System," it was found that a 750-volt direct-current system using only one substation would be suitable for this application. This is particularly fortunate for the reason that the aggregate capacity of the substation equipment, and hence the cost, would be greater if two stations were found to be necessary from the standpoint of satisfactory distribution.

The substation equipment proposed

consists, briefly, of one 750-kw. 750-volt d.c. synchronous converter with suitable transformers to step down from the 22,000-volt, 3-phase, 60-cycle line to a voltage suitable for the converter. The control is of the partial automatic type which will require the services of an operator for starting, but the station will thereafter run continuously until manually stopped. The control includes devices to protect the equipment against overheated converter bearings, overheated windings, flash-overs, faulty power supply, and other contingencies as listed in the switchgear specifications. Two automatic feeder panels are provided, one to serve the tracks going to the washing plant and the other to serve track down to the pit and into the shops.

The cost of the 750-kw. substation is estimated to be as follows:

Synchronous converter and transformer delivered to nearest railway siding	$18,000
Partial automatic switchboard, including two feeder panels	9,464
Installation labor, estimated	3,150
Installation material, estimated	2,360
Building	3,400
	$36,374
Spare armature and fields	5,500
Total	$41,874
Say	$42,000
Average cost per kw.	$56.00

Inasmuch as this is a single-unit station, it is desirable to have on hand the spare armature and other equipment included in the foregoing estimate to serve in lieu of spare capacity. This will give adequate protection, particularly in view of the fact that the substation will be in operation only sixteen hours per day, leaving eight hours to make whatever repairs are necessary should an emergency arise.

Fuel For Steam Locomotives—From previous studies it is found that the thermal efficiency of a steam locomotive in the type of service existing in open-pit haulage is in the order of 2.5 per cent as measured from the B.t.u. content of the coal to the energy delivered at the rims of the drivers. From Table VII the average energy consumption per average round trip of the electric locomotive is shown to be 180.9 kw.-hr. per round trip at the substation d.c. bus. This is for a four-car train weighing 427 tons and carrying 220 long tons of ore. The annual kw.-hr. at the substation d.c. bus for 1,050,000 long tons of ore would be,

$$\frac{1,050,000}{220/\text{train}} \times 180.9, \text{ or } 865,000 \text{ kw.-hr.}$$

The energy consumption at the rims of the driving wheels would be, on the basis of 90 per cent distribution efficiency and an assumed 86 per cent locomotive efficiency,

865,000x0.90, or 779,000 kw.-hr. input to locomotive
779,000x0.86, or 669,000 kw.-hr. at rims of driver

The steam train of four cars weighs more than the electric locomotive hauled train on account of the additional weight of the tender. Inasmuch as the former is 500 tons against the latter's 427 tons, the energy consumption at the drivers of the steamer would be greater—that is,

669,000x(500/427), or 782,000 kw.-hr.

The estimated amount of coal used in ore haulage, based on 2.5 per cent thermal efficiency, 12,500 B.t.u. per pound of coal, and 3,415 B.t.u. per kw.-hr., is

$$\frac{782,000 \times 3,415}{12,500 \times 2.5 \times 2,000} \text{ or } 4,272 \text{ tons}$$

It is noted that in 1930 a total of 4,973 tons of coal was used to haul approximately 980,000 long tons of ore. This would appear to indicate that the estimate of 4,272 tons for 1,050,000 long tons was too low. However, the 1930 haulage was in cars of 72,000 lb. light weight, whereas this estimate is concerned with cars of 58,000 lb. light weight, and moreover it is understood that in 1930 the cars were not loaded as heavily as in this estimate. Therefore, in this estimate the ratio of dead weight to total train weight is considerably less than in 1930, which is a condition that reflects favorably in the amount of coal. Furthermore, it is not known definitely whether the 4,973 tons used in 1930 season was used exclusively for ore haulage or whether it included some small amount of coal for stripping operation.

A further check of this estimate indicates that the equivalent amount of coal per kw.-hr. input to the electric locomotive is

$$\frac{4,272 \text{ tons} \times 2,000 \text{ lb./ton}}{779,000 \text{ kw.-hr.}}$$

or approximately 11.0 lb. coal kw.-hr. This figure compares reasonably close with other experience.

In stripping it is believed that the thermal efficiency of a steam locomo-

Table VIII—Washing-Plant Power

Actual Operating Conditions, 1930–31 Season

(a)	Long tons concentrate (6-mos. period)	657,638
(b)	Long tons crude ore (6-mos. period) (ax1.5)	986,457
(c)	Kw. hr. consumed during 6-mos. ore season	1,124,400
(d)	Kw. hr. consumed during 6-mos. non-ore season	45,000
(e)	Total kw. hr. for a year's operation	1,169,400
(f)	Total power cost	$20,865
(g)	Average cost per kw. hr.	$0.01786
(h)	Kw. hr. per long ton during 6-mos. ore season	1.14
(i)	Kw. hr. per month during non-ore season	7,500
(j)	Ave. contract horsepower during 6-mos. ore season	708
(k)	Ave. contract horsepower during 6-mos. non-ore season	82

Estimated Washing Plant Power for 1,050,000 Long Tons Crude Ore in 5-mos Ore Season

(l)	Kw. hr. during 5-mos. ore season at 1.14 kw. hr. / long ton.	1,197,000
(m)	Kw. hr. during 7-mos. non-ore season at 7,500 kw. hr./mo.	52,500
(n)	Total kw. hr. for washing plant	1,249,500
(o)	Ave. contract horsepower 5-mos. ore season — $708 \times \frac{1,050,000}{986,457} \times \frac{6}{5} =$	900
(p)	Ave. contract horsepower 7-mos. non-ore season	82
(q)	Ave. kw. hr./month 5 mos	239,400
(r)	Ave. kw. hr./month 7 mos	7,500

Note: See Table X for summation of all power.

Table IX—Pit Power for Shovels, Pumping, Etc.

Actual Operating Conditions, 1930–31 Season

(a)	Long tons concentrate (6-mos. period)	657,638
(b)	Long tons crude ore (6-mos. period) (ax1.5)	986,457
(c)	Kw. hr. consumed during 6-mos. ore season	867,900
(d)	Kw. hr. consumed during 6-mos. non-ore season	654,240
(e)	Total kw. hr. for one year of operation	1,522,140
(f)	Total power cost	$28,063
(g)	Average cost per kw. hr.	$0.01845
(h)	Average contract horsepower during 6-mos. ore season	664
(i)	Average contract horsepower during 6-mos. non-ore season	440

Estimated Pit Power for 1,050,000 Long Tons Crude Ore in 5-mos. Season, and 500,000 Yards Stripping

(j)	Kw. hr. per long ton for shovel power	0.22
(k)	Estimated shovel kw. hr. in 1930–31 for 986,457 long tons of crude ore (986,457x0.22)	217,010
(l)	Estimated kw. hr. in 1930–31 for all other power including pumping and perhaps some stripping (e — k)	1,315,130
(m)	Estimated shovel power for 1,050,000 long tons crude ore in 5-mos. ore season (1,050,000x0.22) kw. hr.	231,000
(n)	Estimated shovel power for 500,000 yards stripping in 4-mos. season at 0.40 kw. hr. 1 yd.	200,000
(o)	Total shovel power	431,000
(p)	Estimated power other than shovels. (This is shown less than item "l" as it is believed the latter includes some shovel power for stripping)	1,165,000
(q)	Total estimated pit power	1,596,000

(r) Estimated split-up of items m, n, and p into months.

	Ore Shovel, Kw. hr.	Stripping Shovel, Kw. hr.	Pumping and other, Kw. hr.	Total Pit Power	Estimated Contract Hp.
January	.....	.....	90,000	90,000	440
February	.....	.....	90,000	90,000	440
March	.....	50,000	90,000	140,000	600
April	.....	50,000	100,000	150,000	600
May	46,200	.....	105,000	151,200	670
June	46,200	.....	105,000	151,200	670
July	46,200	.....	105,000	151,200	670
August	46,200	.....	105,000	151,200	670
September	46,200	.....	105,000	151,200	670
October	.....	50,000	90,000	140,000	600
November	.....	50,000	90,000	140,000	600
December	.....	.....	90,000	90,000	440
	231,000	200,000	1,165,000	1,596,000	...

Note: See Table X for summation of all power.
Note: The estimate on contract horsepower in item (r) is based on actual averages shown in items (h) and (i).

Table X—Total Estimated Power Consumption for Production of 1,050,000 Long Tons Crude Ore (700,000 Long Tons Concentrate) and 500,000 Cu. Yd. Stripping

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	Reference
Kilowatt-Hours														
(a) Washing Plant Power	7,500	7,500	7,500	7,500	239,400	239,400	239,400	239,400	239,400	7,500	7,500	7,500	1,249,500	Table VIII
(b) Pit Power — Shovels	.....	.....	50,000	50,000	46,200	46,200	46,200	46,200	46,200	50,000	50,000	.....	431,000	Table IX
(c) Pit Power — Pumps and other	90,000	90,000	90,000	100,000	105,000	105,000	105,000	105,000	105,000	90,000	90,000	90,000	1,165,000	Table IX
(d) Total exclusive of haulage	97,500	97,500	147,500	157,500	390,600	390,600	390,600	390,600	390,600	147,500	147,500	97,500	2,845,500	
(e) Haulage	.....	.....	98,000	98,000	179,500	179,500	179,500	179,500	179,500	98,000	98,000	.....	1,289,500	Table VII-VII-A
(f) Total including haulage	97,500	97,500	245,500	255,500	570,100	570,100	570,100	570,100	570,100	245,500	245,500	97,500	4,135,000	
Contract Horsepower														
(g) Washing plant alone, 15-min. peak	82	82	82	82	900	900	900	900	900	82	82	82	.....	Table VIII
(h) Pit power alone, 15-min. peak	440	440	600	600	670	670	670	670	670	600	600	440	.....	Table IX
(i) Haulage alone, basis 2 locos on grade, 30-min.	.....	.....	490	490	760	760	760	760	760	490	490	.....	.....	Table VII-VII-A
(j) Estimated contract horsepower for washing plant and pit power, 15-min. peak	460	460	620	630	1,160	1,160	1,160	1,160	1,160	620	620	460		
(k) Estimated contract horsepower including washing plant, pit power and haulage, 30-min. peak	460	460	770	800	1,460	1,460	1,460	1,460	1,460	770	770	460		
Power Cost														
(l) Estimated cost of power for washing plant and pit	$1,915	$1,915	$2,688	$2,808	$6,122	$6,122	$6,122	$6,122	$6,122	$2,688	$2,688	$1,915	$47,227 = 1.66¢/kw.hr.	
(m) Estimated cost of power for washing plant, pit and haulage	1,915	1,915	3,936	4,074	7,792	7,792	7,792	7,792	7,792	3,936	3,936	1,915	60,587 = 1.465¢/kw. hr.	

Note: Pit power includes shovels, pit pumping, etc.
Note: Cost of power is based on M.P. & L. Co's P-6 power schedule

Recapitulation

Cost of power for washing plant, shovels, pit and haulage	$60,587
Cost of power for washing plant, shovels, and pit	47,227
Cost of power for haulage alone	$13,360

tive will be in the order of 2 per cent, due to the fact that this work is done during the winter when the temperature is much lower. From Table VII-A the average energy consumption per round trip at the substation d.c. bus is 114 kw.-hr. This is for a five-car train weighing 428 tons and carrying 156 cu.yd. of stripping per trip. The annual kw.-hr. at the substation bus for 500,000 cu.yd. of stripping would be

$$\frac{500,000}{156/\text{train}} \times 114, \text{ or } 365,500 \text{ kw.-hr.}$$

Energy consumption at the locomotive on basis of 90 per cent distribution efficiency would be 365,500x0.9, or 329,000 kw.-hr., and at the rims of drivers, on the basis of 86 per cent locomotive efficiency, it would be 329,000x0.86, or approximately 284,000 kw.-hr.

The steam train of five cars weighs more than the train hauled by electric locomotive on account of the additional weight of the tender. Since the former is 501 tons against the latter's 428 tons, the energy consumption at the drivers of the steam locomotive would be greater—that is,

$$284,000 \times (501/428), \text{ or } 332,000 \text{ kw.-hr.}$$

The estimated amount of coal used in stripping based on 2 per cent thermal efficiency, 12,500 B.t.u. per pound of coal, and 3,415 B.t.u. per kw.-hr., is

$$\frac{332,000 \times 3,415}{12,500 \times 2.5 \times 2,000}, \text{ or } 2,267 \text{ tons}$$

Equivalent pounds of coal per kw.-hr. at locomotive is approximately

$$\frac{2,267 \times 2,000}{329,000} = \text{approximately } 13.8$$

Summary of Coal Consumption

Total coal, ore haulage, tons	4,272
Total coal, stripping, tons	2,267
Total, tons	6,539
Cost of coal per ton	$7.25
Total cost of coal	$47,408
Total kw.-hr. at locomotive for ore haulage	779,000
Total kw.-hr. at locomotive for stripping	329,000
Total	1,108,000

Equivalent pounds of coal per kw.-hr. locomotive for ore haulage and stripping is

$$\frac{6,539 \times 2,000}{1,108,000}, \text{ or approximately } 11.8 \text{ lb./kw.-hr.}$$

Locomotive Maintenance — Electric locomotive maintenance is based on Interstate Commerce Commission reports which indicate that under heavy haulage conditions on grades the cost is slightly over 7c. per locomotive - mile per 100 tons on drivers. This is a twelve - year average of the experience on four different properties. With this as a basis, the maintenance of a 65-ton locomotive would be 7.0 x 0.65 = 4.55c. per locomotive - mile. To this amount there is arbitrarily added 20 per cent to take care of contingencies or provide for possible increases due to the small number of locomotives, making a total of 4.55x1.2, or, say, 5.5c. per locomotive-mile.

Average length of round trip in ore haulage, miles	8.8
Number of round trips based on 1,050,000 long tons at 220 long tons per trip	4,773
Total locomotive-miles in ore haulage, 4,773x8.8	42,000
Average length of round trip in stripping, miles	6.45
Number of round trips based on 500,000 cu. yd. at 156 cu. yd. per trip	3,200
Total locomotive miles in stripping, 3,200x6.45	20,640
Total locomotive-miles per annum	62,640
Total cost at 5.5c. per locomotive-mile	$3,445

Table XI—Cost of Distribution System

606	Pole structures complete with fixtures set in ground on 47,200 ft. of permanent track, 30 per cent of which are guyed or braced	$26,000
275	Portable poles complete with fixtures, in place	7,150
	Total cost of poles in place, approximately	$33,150
11	Portable pole dead ends (drag anchors)	
12	Dead ends, anchor type, with 35-ft. pole	
64	Miscellaneous back guys, installed	
6	Cable reel connectors, installed	
10	Pole-mounted, manually operated sectionalizing switches	
	Total	$3,588
54,250	Lb. copper at 18c. delivered	9,765
	Installation of copper at 3c. per lb	1,627
	Total of above	$48,130
12.05	Miles track bonding at $350 per mile	$4,225
	Miscellaneous cross bonding	423
10	Ties between contact wires on double track for conductivity and	
	Power feed from substations, two positive and one negative.	1,500
	Total	$54,278
	Add 10 per cent for contingencies	5,428
	Estimated total cost	$59,706
	Say	$60,000

there is arbitrarily added 20 per cent to take care of contingencies or provide for possible increases due to the small number of locomotives, making a total of 4.55x1.2, or, say, 5.5c. per locomotive-mile.

Steam Locomotives — The maintenance cost of steam locomotive, including back shop repairs, is $2,000 per year per locomotive, or for four locomotives, $8,000 per year.

On the basis of four steam locomotives working 120 days of two 8-hr. shifts in ore and 80 days of two 8-hr. shifts in stripping, there would be 12,800 annual locomotive operating hours. The maintenance cost on a per-hour basis would therefore be $8,000÷12,800, or $0.625 per operating hour.

Maintenance figures on railway steam switching locomotives show, in general, a higher cost per hour. For example: American Railway Association figures covering maintenance cost of switching locomotives of comparable weight give costs from $1.15 to $2.25 per operating hour. This is in a type of service where coal consumption is in the order of 580 to 670 lb. per locomotive-hour. The amount of coal calculated for the pit under consideration was 6,539 tons, which, for a total of 12,800 locomotive-hours, would give a rate of 1,020 lb. per hour, an amount considerably in excess of the figures taken from Association reports. On the assumption that maintenance cost increases with fuel consumption, it would seem that the cost per operating-hour for steam locomotives in this pit should be in excess of the Association figures—perhaps even as high as $2.50 per hour.

However, the amount of $2,000 per locomotive per year is used in this analysis for steam locomotives, as it is stated to be actual cost.

Crew Wages—Only one man is considered to be in the cab of the electric locomotive. The train crew will therefore consist of engineer and brakeman and for the steam locomotive an engineer, fireman, and brakeman.

The study on duty cycles indicates that three electric locomotives can produce the specified average and maximum tonnage of ore per 8-hr. shift at present levels. It is believed, therefore, that it will not be necessary to consider initially the use of more than 3½ locomotives—that is, three locomotives for the full time of two shifts per working day and the fourth locomotive one shift per working day. On the other hand, the steam locomotives have to take out time for coal and water, and it is therefore assumed that all four locomotives will be working full time.

	Ore	Stripping	Total
Number of days of operation	120	80	200
Number of 8-hr. shifts	240	160	400
		Steam	Electric
Number of locomotives working		4	3½
Number of locomotive shifts at 400 shift per locomotive per year		1,600	1,400
Engineer's wages per 8-hr. shift 99c./hr		$7.92	$7.92
Fireman's wages per 8-hr. shift 76c./hr		6.08	.....
Brakeman wages per 8-hr. shift 62.5c./hr		5.00	5.00
Total engineers' wages		$12,672	$11,088
Total firemen's wages		7,728	.....
Total brakemen's wages		8,000	7,000
Total crew wages		$30,400	$18,088

Lubricants—The cost of lubricants on electric locomotive is nominal and consists of a few pounds of grease for armature bearings and a few gallons of oil for axle bearings and journals, and oil for compressors. It is estimated that the entire cost will not exceed $50 per year.

The lubricants for steam locomotives cost $1.25 per locomotive per day. On the basis of a total of 200 operating days per year, and four steam locomotives, the total annual cost for lubricants will be 200x4x$1.25, or $1,000.

Water for Steam Locomotives—The total amount of coal burned in steam locomotives is 6,539 tons, or 13,078,000 lb. The usual water rate is about 1 gal. per pound of coal burned, thus giving an annual water use of approximately 13,000,000 gal. The cost is assumed to be 10c. per 1,000 gal., which would give an annual cost of about $1,300.

Table XII—Estimate of Cost of Maintaining Substation and Distribution System

	Steam Man-hours	Electric Man-hours
For maintenance of electric shovels and washing plant under steam operation		
2 men, 200 8-hr. shifts (days)	3,200	.....
1 man, 200 8-hr. shifts (nights)	1,600	.....
For maintenance of electric shovels and washing plant, distribution system, and electric substation under electric operation including shifting of five miles of contract wire		
Ore season —		
7 men, 120 8-hr. shifts (day)	....	6,720
1 man, 120 8-hr. shifts (night)	....	960
Stripping season —		
4 men, 80 8-hr. shifts (day)	....	2,560
1 man, 80 8-hr. shifts (night)	....	640
Total estimated man-hours	4,800	10,880
Annual cost at 70c., average per hr.	$3,360	$7,620
Estimated cost of material for distribution system	....	800
Estimated cost of supplies for substation	....	200
Total estimated cost of electric maintenance	$3,360	$8,620

Engine-House Expense—Steam locomotives incur engine-house expense for cleaning fires, dumping and disposing of ashes, washing boilers, hostling, and watching. It is estimated that a conservative cost for this work would be the equivalent of sixteen man-hours per working day for 200 days at 75c. per man-hour, or a total of $2,400.

Electric locomotives do not require such attention, and therefore no charge is made against them for engine-house expense.

Maintenance of Electric Substation and Distribution System, including Shifting of Contact Wire—Operation of an open-pit mine requires that sections of track be shifted from time to time as digging progresses. When electric locomotives are used an extra operating cost is incurred for moving the corresponding amount of overhead contact wire. Most of this work is in connection with temporary track where portable poles with bases are used. The labor involved in relocating these depends on whether the track is merely moved over a short distance or relocated at a considerable distance. In the former case it may be possible to move the portable poles without removing the contact wire, but in the latter the wire would have to be removed, rolled up, and restrung after the poles were set up in the new location.

In this particular operation it has been estimated that a total of about five miles of track will be moved each year. The work of moving the corresponding amount of overhead contact wire is usually performed by a line gang which would normally also take care of distribution system maintenance, and electrical maintenance of substation, shovels and washing plant, as well.

From experience on other properties it is estimated that work of this nature could be performed by six men and one foreman, working 120 8-hr. day shifts during the ore season, and by three men and one foreman, working 80 8-hr. day shifts during the stripping season. The night shift during both the ore and stripping season would normally be handled by a single man except in an emergency, when the regular crew would be called out. Table XII gives a comparable estimate of electric maintenance for both steam and electric operation.

Fixed charges—The basis of the fixed charges shown in Table No. II is as follows:

Electric	
Taxes and insurance	
2% of gross investment of $232,000	$4,640
Interest and finance charges	
6% of gross investment of $232,000	13,920
Depreciation	
Locomotives — 4% of first cost of $130,000	5,200
Distribution system 8% (12-year life) of first cost of $60,000	4,800
Substation	
4% of material, $34,824	1,393
8% of labor and building, $7,176	574
Total	$30,527

Average fixed charge $\frac{\$30,527}{232,000} \times 100 = 13.2$; say, 13%

The depreciation is based on 25-year life of movable equipment and twelve-year life of the immovable equipment. Life of mine is stated to be twelve years.

Steam	Per Cent
Taxes and insurance	2
Interest and finance	6
Depreciation	8
Total	16

It is believed that the steam locomotives will have little if any value at the end of twelve years, due to the fact that the amount of $2,000 per locomotive per year charged against maintenance does not seem sufficient to keep the locomotives in good repair. Hence a depreciation charge of 8 per cent, corresponding to twelve years' life.

USEFUL OPERATING IDEAS

New Truck Speeds Handling Of Mine Timber

AT THE MERRITT MINE on the Cuyuna range in Minnesota, a new idea for handling large timber with one man was developed that reduced labor and speeds delivery. It makes unnecessary more than one loading of the timber between the surface pile and underground. It can be applied in a small 5x5-ft. cage compartment or can be designed for larger shafts or to take care of timber of any size. The truck frames at this mine are of wood, but at the Armour No. 2 mine, where truck and cage have been built to make use of this idea, the trucks are all steel, writes L. C. Moore, of Hibbing, Minn.

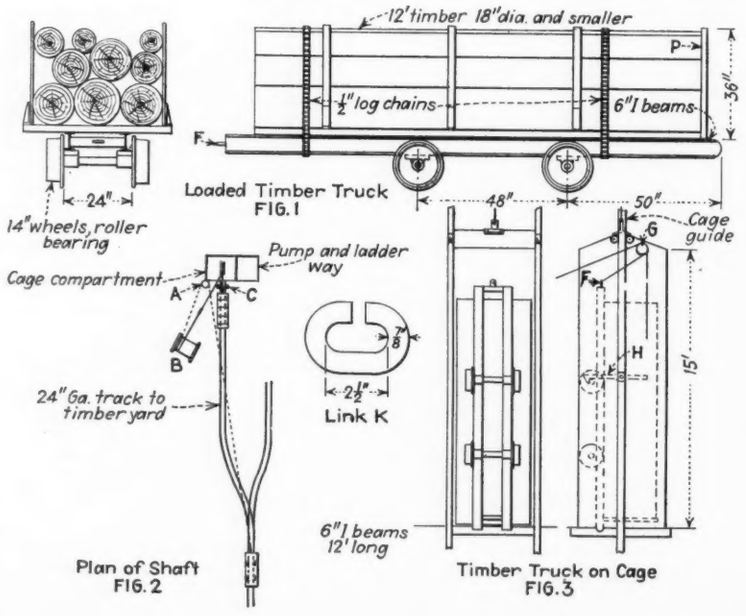
Fig. 1 shows a truck loaded with timber 12 in. in diameter and 12 ft. long. After framing, the timber is rolled on the truck with one end snug against the vertical shelf *P*, which is built firmly into the truck. On the drawbar end, *D*, the 6 in. side frames extend several inches beyond the shelf and are made round. These rounded ends fit into sockets on the cage when the truck is tipped to a vertical position. Side latches are also provided on each side of the cage to hold the truck snugly as it is lowered underground.

In sending timber underground the procedure is as follows: The loaded timber truck is pushed by hand to a position, in Fig. 2, on the 24-in. track far enough from the switch to allow an empty truck to be set out when it comes up from underground. When the cage comes up with the empty timber truck, ½-in. steel cable, about 25 ft. long, is attached to the top end of the truck at *F*, Fig. 3, threaded through the 8-in. sheave block fastened to the top of the cage at *G* with the falls resting on the cage floor, and a closed socket is fastened to the floor end of the cable.

The timber man on the surface attaches this ½-in. cable to a ½-in. cable on a single-drum 5-hp. electric hoist at *B*. This hoist has a drum full of cable, and the cable end also is equipped with a closed socket. The man connects the two cable sockets with an open link, *K*, shown on the sketch, starts the hoist motor, and puts tension on the cable until the latches *H* can be raised by a rod alongside of the cage. He then slackens off and the empty timber truck drops to the track from the vertical to a horizontal position. He unhooks it and runs the truck on to the siding.

Next he disconnects the open link, threads the cable through the match block on the surface level at *A*, and reels the cable off the drum until he can hook on t the loaded timber truck. Next he goes to the hoist, pulls the truck to the shaft with the cable, then disconnects the drum cable and fastens the short cable on the cage to the end *F* of the truck. Half-inch log chains, as shown, are pulled tight around the logs and truck, binding the load so there is no chance of the logs loosening. After connecting the two closed sockets with the link *K* as before, he pulls the truck toward the cage until the two front wheels hit bump blocks *C* attached to the track. As he continues pulling, the truck end *F* starts to rise and the ends *D* settle into sockets in the floor of the cage, allowing the loaded timber truck to rear itself vertically on the cage until it is locked tight with the latch *H*. The link *K* is removed from the cage cable socket, the cage cable is coiled on the cage floor, and the cage is rung down to the underground level, where the same procedure is repeated.

By building the cage the desired length, this scheme can be modified for any size of timber needed. The operation is so simple and safe that very little skill is required and, with a little practice, speed can be made in changing trucks on the cage. Everything needed, with the exception of the slusher hoist, can be built in the shops.



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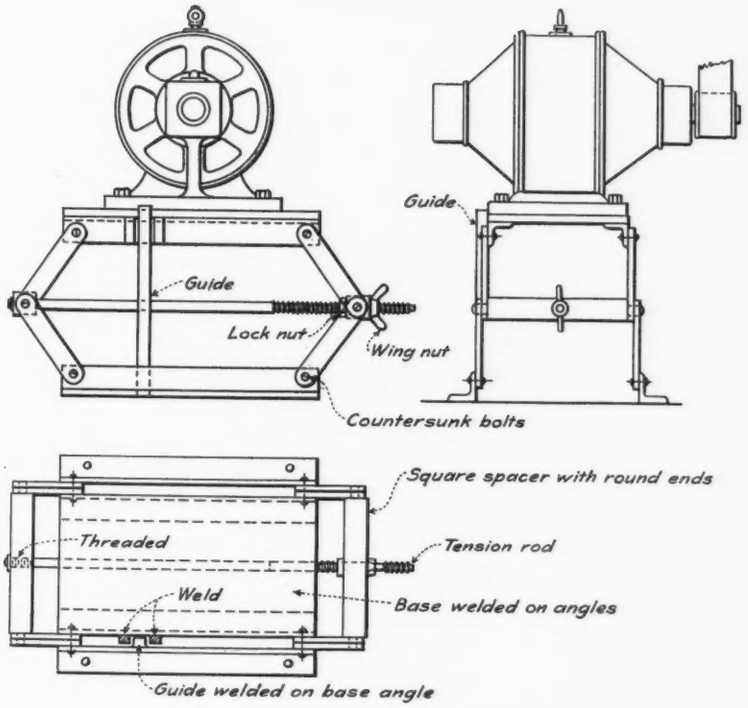
Adjustable Motor Mounting

SIMPLE yet efficient type of adjustable motor mounting for vertical drives is illustrated herewith, details of the design and operation of which have been kindly supplied by Phil Keast, shop foreman, Empire Star Mines Company, Ltd., Grass Valley, Calif., where several units are successfully at work.

Explained briefly, the mounting proper consists of the upper motor base plate welded on to two angle-irons, which is connected to the two base angle-irons by means of a toggle arrangement controlled by a long, threaded tension rod. One end of this rod is screwed into the spacer holding together the toggle levers, and the opposite end fits loosely into the hole in the center of the second spacer, and is fitted with a lock nut and a wing nut. Both spacers are made from square mild steel.

Stability and constant alignment of the mounting proper is provided by

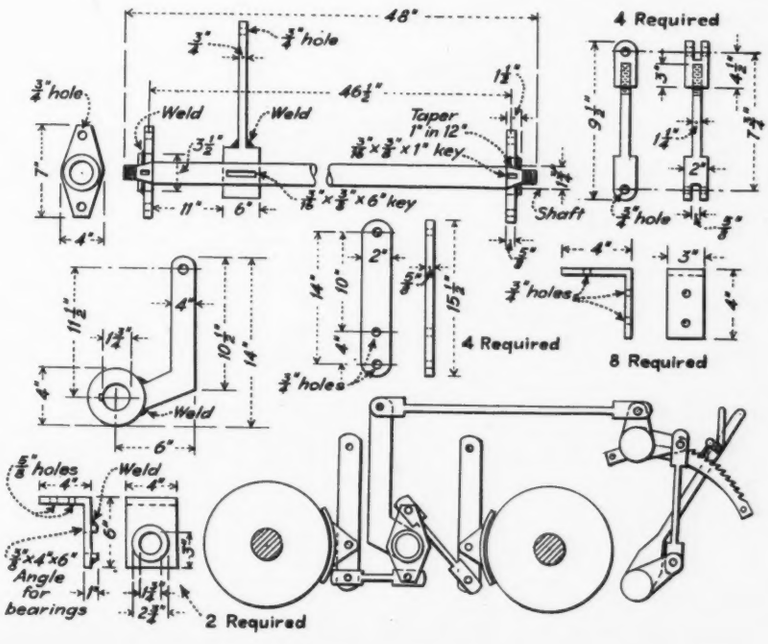


the sturdy guide welded on to one of the lower angle-irons and operating between the two pieces welded to the upper base. Adjustment of the belt tension is simple and rapid. The motor base can be raised or lowered first by loosening the lock nut and then adjusting the tension rod to proper length by means of the wing nut. After the desired belt tension has been obtained, the lock nut is against tightened, and the motor is ready for operation.

A Brake for Mine Locomotives

THE efficient snatch brake shown in the accompanying sketch was designed and built to replace the intermediate shaft brake used on a 6-ton Type WLDT Ironton locomotive, a combination battery-and-trolley unit, which we decided to convert into straight reel-and-trolley, writes Charles S. Loomis, master mechanic of Mine No. 4 of the Hatfield-Campbell-Creek Mining Company, of Rensford, W. Va. After taking the batteries out we found room enough to try this type of brake. It proved satisfactory.

Two methods can be used in controlling brake pressure, one the screw type and the other the snatch type. However, they are optional, both being efficient. By a few changes, according to conditions, this brake can be built and installed at a very low cost.



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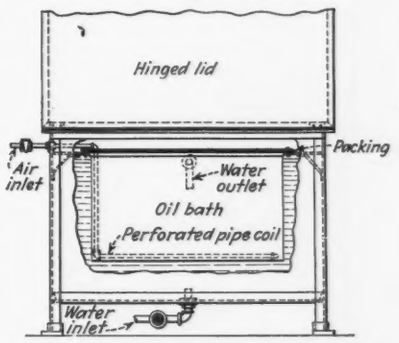
For Tempering Drill Steel

WITH the use of more efficient steels for the manufacture of rock drills, parts, and replacements for underground and surface machinery, the problem of tempering these units correctly has become a primary factor at the mine, mill, and smelter blacksmith shop. Tempering of steel is accomplished by various methods, depending on the composition of the materials. Some require cooling in water, and others are worked in oil or air. To obtain the best results, the cooling liquids must be kept at more or less even temperature in tanks specially designed for the work.



A water-cooled oil bath arrangement for tempering drill shanks and special machine parts, which has given good results at a large gold-silver mine in Central America, is shown. As will be seen, it consists of two separate tanks made from plates and angle irons. The smaller tank holding the oil is bolted to the flange in the interior of the large tank, with a rubber packing making the joint watertight. Pipe connections include an air line ending with a perforated pipe coil at the bottom of the oil receptacle, and a water inlet and outlet on the water tank. Rock-drill shanks are tempered in the ordinary oil bath cooled by water, but special steels and machine parts are treated in oil gently agitated by a small amount of compressed air. By removing the oil from the tank, the device will lend itself to air tempering. Should the oil be ignited in the tank, the blaze can be extinguished immediately by lowering the hinged lid.

Gold Mining in Costa Rica

Numerous Small Operations Are Yielding $600,000 Annually

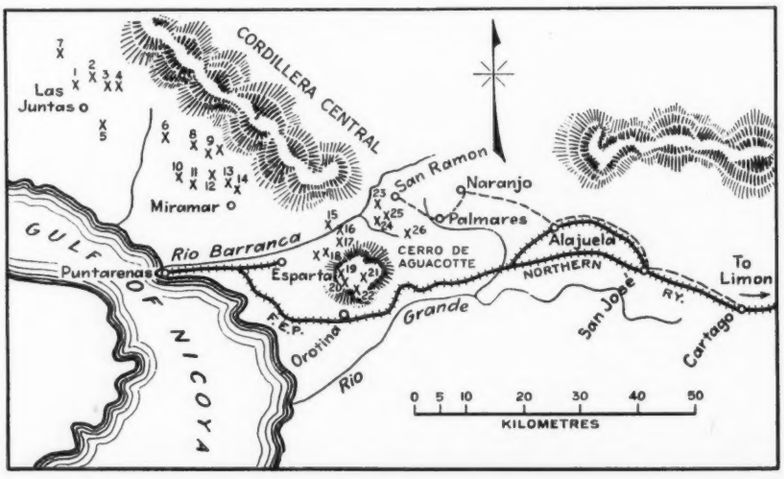
Evan Bennett
Mining Engineer
San Jose, Costa Rica

MINING in Costa Rica, at present limited to gold, has unique and interesting features due to the mild climate and cheap labor. Although individual operations are small, the production in the aggregate is not inconsiderable, amounting currently to about $600,000 annually, gold only. Early in the Spanish conquest, rich mines were worked in the Aguacotte district. Later, large family fortunes were founded on gold workings in that area. Early in the present century, the Abangares and La Union mines produced about $1,000,000 a year, each, for a number of years, using hundreds of stamps and cyaniding in Pachuca tanks. These mines have dwindled to dump-salvage and leasing operations, but many smaller mines have opened on new discoveries, with the plants ranging from those comprising a tiny ball mill and plates to the modern Santa Elena plant, which combines flotation of slimes with cyaniding of sands and slime concentrates at 50 tons daily. The gold-mining district (Figs. 1 and 2) comprises an area extending 70 km. along the Cordillera Central and about 20 km. wide. Many parts are unexplored, and discoveries of new veins are common.

The Cordillera Central is a diorite batholith, intruded by Tertiary andesites as dikes and flows. Gold-bearing veins appear to be related to these dikes, usually occurring in the diorite near the intrusive. Sediments are fragmentary and few. Many deposits are of distinctly hydrothermal origin, carrying calcite, cinnabar, and manganese minerals, as well as auriferous pyrites. The youth of many veins is shown by attenuation and branching at the higher ground levels. Oxidation usually disappears at 100 ft. depth or less. Values often diminish at the sulphide zone, with notable exceptions. The Veta Negra of La Union mine was richest and widest at 800 ft. depth, and was worked down to the 1,200 level. Vein filling in general is soft quartz, *broza,* in the upper levels, sometimes a tough, sticky gray clay with quartz stringers known as *jabonada.*

Milling methods are modified by the cheap labor and the character of the ores. Mechanical feeders are almost

GOLD MINING district of Costa Rica. The mines are numbered, to correspond to the legend



LEGEND

1. 2. 3. 4. 5. Minas de Abangares
6. Guacimal
7. Libano
8. El Encanto
9. Bonanza, also La Union
10. Domingo
11. San Antonio
12. Trinidad
13. Bella Vista
14. Montezuma
15. Buena Suerte
16. Domingo Rodriguez
17. La Fortuna
18. Santa Elena, also Santa Clara
19. Llano Brenes
20. La Britania
21. Sacrafamilia
22. La Union de Aguacotte
23. Orlich
24. San Gerardo
25. Penon
26. Santa Teresita

unknown; instead, a peon shovels from the bin or platform where ore is dumped. Soft ores are washed in a trommel scrubber ahead of the crusher. Classification and closed circuits are rare, the usual mill being of the grate-discharge type with a 40-mesh screen. Plate amalgamation is general, followed by corduroy or flotation. Concentrates often are low in grade, and shipping and smelting costs are a heavy item. Only three mines have cyanide plants and all use mechanical agitation. Several are planning installation of small concentrate-cyaniding equipment to avoid the heavy export cost and long delayed returns. In view of favorable climatic conditions, the housing of mills is simple, a corrugated metal roof sufficing.

Ore transport is by man or mule trams and jig-back cableways. From outlying veins it is commonly hauled by oxcart, or by pack horses carrying gasoline tins filled with ore. The *cajuela* is a standard measure for custom ores and leasing operations, equivalent to about 75 lb. Two to four are carried on a pack animal. Timber for mines of tropical hardwood is cut in the vicinity and hauled in by oxen. Tunnel frames and square-sets are contracted at 12c. to 24c. per meter. Lumber for construction is cut by hand and delivered at 2c. to 3c. per board foot. Water power is abundant. Many mills are driven directly through Pelton wheels. Small stamp mills and arrastras use overshot wheels. The American-owned power company's network traverses the mining district.

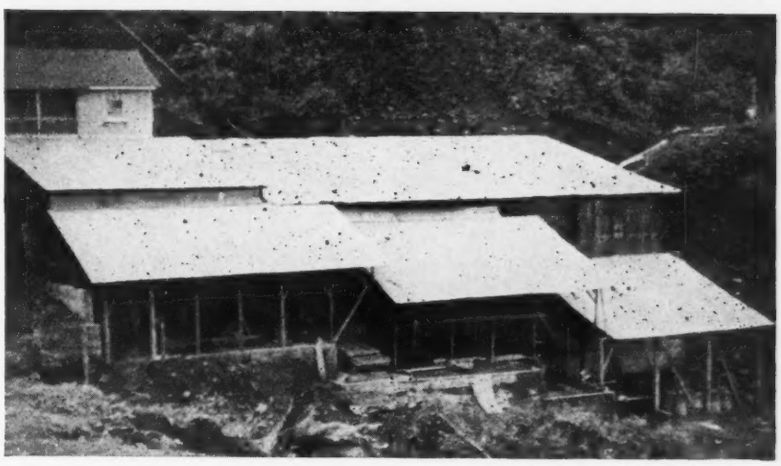
Transport to the mines is mainly by oxcart, only a few properties being accessible by motor truck during the dry season. Though slow, oxcart transport is very cheap. The Ferrocarril Electrico al Pacifico is a Government-owned railway with excellent service and low tonnage rates. It skirts the southern end of the district. Air passenger service from the capital, San Jose, to San Ramon, Puntarenas, and all other important points in the Republic is frequent, dependable, and cheap. From San Ramon, Las Juntas, or points on the railway one goes by horseback, taking two to six hours to arrive at the various mining centers. Transport nearly stops during the worst of the rainy season from September through November. January and February are almost rainless.

The present rate of exchange, 5.61 *colones* to a United States dollar, favors the miner selling gold at $35 per oz. Common labor is paid 2½ to 3½ *colones* per day per 8-hr. shift, and miners and timbermen receive 4 to 5 *colones* per shift. All drilling is by hand. Cost of mining ore from cut-and-fill stopes, delivered at the mill, is from 6 to 10 *colones* per ton. Tunneling and raising costs 35 to 50 *colones* per meter, including timber and powder. The labor supply appears ample, especially since laborers prefer the mining regions, which are healthy, to the plantations on the coast. The Rudin mines and some others provide good quarters and other facilities for miners, but living conditions are deplorable at some of the smaller properties. Miners out of work often become *colagalleros,* mining rich stringers in abandoned mines or denounced veins, and milling them by hand with mercury in *molinetes.* Stealing of high-grade ore and amalgam is common in the larger mines as elsewhere.

Only few supplies are more expensive than in the United States, and mostly those imported therefrom. German cement, steel, and electrical apparatus are in common use. There are excellent small shops and foundries in San Jose, where small mills, classifiers, tanks, and other machinery are made to order, including replacement parts such as mill liners, balls, and others. Powder, on the other hand, is expensive because of the stringent rules governing its handling and storage. DuPont products are handled by one agent only.

No large foreign companies are represented among the mines currently active. In general they are financed and operated by Costa Ricans or individual Americans. Rudin & Cia., a relatively recent mining enterprise, operates the Santa Elena, Trinidad, Bonanza, and El Encanto mines, with a combined milling capacity of 150 to 200 tons a day. It is capably managed and largely owned by Albert Rudin. His Santa Elena mine is a remarkable lens of manganiferous gold ore requiring extraordinary treatment because of its colloidal properties. The plant now in process of completion comprises classification by means of shaking tables, flotation of slimes, and cyanidation of sands and slime concentrates.

Abangares Gold Mines is a 50-year concession, with ten years yet to run, over a large area at the north end of the mining district. It operates on a leasing system—that is, individual



THE SANTA ELENA mill (above). Operated by Rudin & Cia, this treats a manganiferous gold ore from the Santa Elena mine by shaking tables, slime flotation, and cyanidation of flotation concentrates and the sands. Below, THE SAN GERARDO mine, operated by Gonzalo Moncada, produces a rich gold ore, occurring in pockets, that is treated in this 50-ton mill

mines are being leased under a 25 per cent royalty which includes milling in a central plant consisting of stamp and ball mills, and a cyanide unit. Ores carrying less than an ounce of gold per ton are not accepted. This concern exported $173,328 in bullion during the first half of 1938.

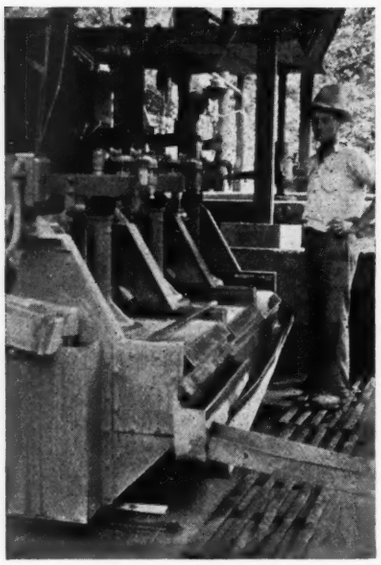
La Union de Aguacotte and the Sacrafamilia, famous old producers, are operated on a reduced scale. The San Gerardo mine, with 50 tons milling capacity, is notably rich, though pockety. It is owned and operated by Gonzalo Moncada, a Costa Rican. Numerous small mines operate cooperatively, with high-grade ore being hauled on pack animals to small stamp mills or arrastras. Generally they are financed by some local merchant or rancher. Recoveries are low, rarely more than 50 per cent, but usually sufficient to cover the very low costs and *"algo mas tambien."* It is a tribute to the character of Costa Ricans that most of these communal mines carry on without friction.

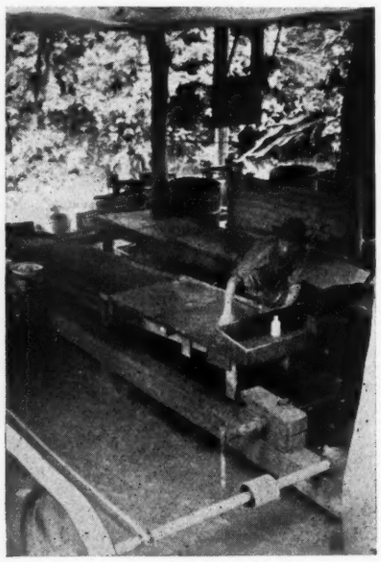
Apart from lode gold mining there is practically no production of minerals. There have been several explorations of placers along the rivers flowing into the Golfo Dulce. Among several hundred lawless gold washers sanguine battles have been fought for possession of certain bars along the Tigre and Nuevo rivers held under denouncement by Dulce Mines, Inc. During the World War, shipments of manganese were made from deposits bordering the coast in Nicoya and Guanacaste. Recently, interest in these deposits has been revived, several small lots have been shipped, and the old claims denounced. Many copper deposits are known, but to date they are not developed commercially.

Costa Rica is one of the most stable politically of the Latin American republics. Literacy is high, and the Government is about as near to a true democracy as that of the United States.

Sound foreign enterprise is welcomed by Costa Ricans officially as well as personally. As the majority of the population is white, Americans and Europeans are not distinguished as foreigners if they speak Spanish and respect local customs. Property taxes are almost nonexistent, as the Government is supported by various utilities and monopolies. Mining equipment is imported duty-free by holders of titled claims, whose only tribute is a 3 per cent export tax on gold. The mining law is the usual Spanish system of denouncements of mineral deposits and tenure during active exploitation. However, because of absence of a mining bureau or other effective government regulation, there is much conflict between claims. The attractiveness of a prospect may often be judged by the number of claimants to the title.

Although gold is the third or fourth most important export, and despite the fact that the larger part of it is mined by wholly local enerprises and Costa Rican citizens, it received little attention officially. A survey of the country's mineral resources, a geological map, and a competent official to represent the mining industry in the Government would aid this growing industry and hasten development of the almost uninhabited areas along the northern and southern frontiers of the country.





FLOTATION CELLS (left) at the Llano Brenes mine. The location of this and the other properties mentioned in the text is shown on the accompanying map. Right, DRESSING amalgamation plates at the Llano Brenes mine

Checking Up Eye Injury Claims

A device that is successful in detecting malingering

INDUSTRIAL EYE INJURIES, as most employers know only too well, frequently result in claims or suits for damages. Very often it is difficult to decide the extent of the injury, thereby complicating a just settlement. In addition, claimants may deliberately sham loss of sight to collect damages to which they are not entitled.

To protect both employer and employee, an eye shamming test was recently made available. This new test determines instantly and beyond the shadow of a doubt whether or not an eye has actually suffered loss of sight. Furthermore, the test determines the visual acuity of the eye. It is therefore impossible to sham successfully loss of sight in the face of such an examination.

The value of this malingering test, developed by researchers of the American Optical Company, Southbridge, Mass., has recently been proved. A $50,000 damage suit had been filed against a truck company in the common pleas court of Akron, Ohio, the plaintiff alleging that injuries suffered in an accident involving the truck company had destroyed the sight of the right eye.

A doctor who had examined the plaintiff in his office was called on the stand. He testified that the malingering test had clearly showed the plaintiff could see equally well with both eyes. Then he demonstrated the test in the courtroom. The jury returned a verdict in favor of the defendant, and the $50,000 damage suit was dismissed.

The functioning of this unique eye test is dependent on the use of Polaroid, the recently developed material which has the power to polarize light so that it vibrates in one plane only. The equipment used consists of a projector, a small screen on which to project test letters, Polaroid spectacles, and a cross slide which is equipped with Polaroid lenses for use in the projector.

By taking advantage of Polaroid's ability to harness light rays, it is possible for an examiner to cut off a subject's line of sight between either eye and letters projected on the chart, all without the subject suspecting it. In other words, the subject does not know with which eye he is seeing. It is thus impossible for him to fake an injury in either eye, as his malingering will inevitably be revealed by the tests herein detailed.

NEW BOOKS

MINERAL VALUATIONS OF THE FUTURE. *By C. K. Leith. Published by American Institute of Mining and Metallurgical Engineers, 29 West 39th St., New York, N. Y. Pp. 116. Price $1.50 to non-members, $1 to members.*

THIS VOLUME is the eighth of the A.I.M.E. series designed primarily to appeal to the younger members of the mining engineering profession. It is published for the Seeley W. Mudd Memorial Fund, and a complimentary copy will be presented to each Junior member of the Institute. The author is professor of geology at the University of Wisconsin and is widely noted for his interest in, and contributions to, the political and economic aspects of the mineral industries. On the subject of valuation he speaks with recognized authority.

Dr. Leith's thesis is the influence of changing economic, social, and political conditions on generally accepted technical methods of mineral valuation. Among the new conditions affecting mineral values are such factors as economic nationalism, legislation, taxation, tariffs, social security measures, production and price control, labor organization, competition of metals for industrial use, changing trends in consumption, effect of secondary and scrap metals, and the shadow of war. These elements are discussed in some detail, as are various methods of mineral valuation. Attention is given to estimating future annual production from mineral deposits, and production trend lines are calculated for several major minerals by way of illustration. Cost, selling price, profit, and rate of return on mining investment are all discussed with respect to future valuation. In a concluding chapter the author lists two sets of trends favoring increase and decrease, respectively, of future mineral values. Note is also taken of the tendency to transfer mineral values from private to public control. All of these trends show that methods of appraising mineral values must be flexible enough "to allow for a wide range of technologic, commercial, political, and social factors now becoming apparent."

GERMAN GRAMMAR FOR CHEMISTS AND OTHER SCIENCE STUDENTS. *By John T. Fotos and John L. Bray. John Wiley & Sons, Inc., New York. Pp. 323. Price $2.25.*

MESSRS. Fotos and Bray, who are, respectively, professor of modern languages and head of the school of chemical and mechanical engineering at Purdue University, have prepared this book as a course in chemical and scientific German for students who have not studied German previously. Rules of grammar are therefore presented simply and in minimum space, and attention is directed to building up an adequate working vocabulary as quickly as possible. To the end of choosing the most useful words, the authors say they have given much time to determining the frequency with which the words selected occur in technical literature, and similarly with respect to grammatical construction. An important part of the book is devoted to graded readings based on these frequency studies. Unquestionably the authors have turned out a product unique in the teaching of modern languages. Even those who have had considerable preparatory German will find the book useful for its vocabularies.

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PUBLICATIONS
RECEIVED

Manganese (Second Edition). By A. W. Groves, Mineral Resources Department, Imperial Institute, South Kensington, S. W. 7, England. Pp. 164. Price 1s. 6d., net. Postage 4d.

Lexicon of Geologic Names of the United States, Including Alaska. In two volumes. Compiled by M. Grace Wilmarth. Bulletin 896, U. S. Geological Survey. Total pages 2,396. For sale by Superintendent of Documents, Washington, D. C. Price per set (bound in paper). $2.50.

Radium Protection. National Bureau of Standards Handbook H23, superseding Handbook H18. A manual of recommended precautions to be observed by those whose work involves the handling of radium. For sale by the Superintendent of Documents, Washington, D. C. Price 10c.

Determination of Lead in Air. Preventive Engineering Series. Bulletin 2, Part 6. Air Hygiene Foundation of America, Pittsburgh, Pa. Pp. 18.

Report of the Committee on Prices in the Bituminous Coal Industry. Prepared for the Conference on Price Research. National Bureau of Economic Research, New York. Pp. 144. Price $1.25.

Spectrochemical Analysis in 1938. A companion book to "Spectrochemical Abstracts, 1933–38." By F. Twyman. Adam Hilger, Ltd., 98 St. Pancras Way, London. N. W. 1, England. Pp. 67. Price 4c. 6d. post free.

Industrial Instruments and Changing Technology. By George Perazich, Herbert Schimmel, and Benjamin Rosenberg. W.P.A. National Research Project, Report No. M-I. Publication Section, Divisional Information, Works Progress Administration, Washington, D. C.

Capital Consumption and Adjustment. By Solomon Fabricant. National Bureau of Economic Research, Inc., New York. Pp. 271. Price $2.75.

The Preservation of Business Records. Prepared by Business Historical Society, Inc., Baker Library, Soldiers Field, Boston, Mass. (A pamphlet.)

Directory of Association of Consulting Chemists and Chemical Engineers, Inc., 50 East 41st St., New York, N. Y. Members listed alphabetically and geographically. A useful feature is a detailed statement of special facilities and general scope of activities of each member.

Igneous Geology and Structure of the Mount Taylor Volcanic Field, New Mexico. By Charles B. Hunt. Professional Paper 189-B, U. S. Geological Survey. Sold by Superintendent of Documents, Washington, D. C. Pp. 51–80, plus maps and plates. Price 45c.

Geology and Mineral Resources of the Honeybrook and Phoenixville Quadrangles, Pennsylvania (containing various deposits of magnetite, including those of the French Creek mines, and other minerals). By F. Bascom and G. W. Stose. Bulletin 891, U. S. Geological Survey, Washington, D. C. Pp. 145. Price 65c.

Metallurgical Division Progress Reports. No. 26. Fixation of Sulphur from Smelter Smoke. By A. H. Robertson and G. W. Marks. R. I. 3415, U. S. Bureau of Mines, Washington, D. C.

Flotation for Recovery of Scheelite From Slimed Material. By E. S. Leaver and M. B. Royer, U. S. Bureau of Mines, Technical Paper 585. Superintendent of Documents, Washington, D. C. Pp. 24. Price 10c.

Gold Placers of the Fortymile, Eagle and Circle Districts, Alaska. By J. B. Mertie, Jr. Bulletin 897-C. U. S. Geological Survey. Pp. 129. Sold by Superintendent of Documents, Washington, D. C. Price 20c.

Placer Mining on the Rogue River, Oregon, in Its Relation to the Fish and Fishing in That Stream. By Dr. H. B. Ward. Bulletin 10, Department of Geology and Mineral Industries, 704 Lewis Building, Portland, Oregon. Pp. 31. Price 35c.

Virginia. Outline of the Geology and Mineral Resorces of Goochland County. By C. B. Brown, Bulletin 48, Geological Survey, University, Va. Pp. 68.

Some Arizona Ore Deposits. Papers prepared by various authors and presented at Regional Meeting of A.I.M.E., at Tucson, Ariz., Nov. 1-5, 1938. Practically all important mining districts of the State are covered. Bulletin 145, Geological Series No. 12, Arizona Bureau of Mines, Tucson, Ariz. Pp. 136, plus a supplement of 38 unbound maps and charts. Price, 35c. outside of Arizona.

Annual Report (Vol. XLVI, Part I, 1937). Ontario Department of Mines, Toronto, Ont. Includes a list of mines and quarries. Pp. 291.

Mineral Production of Canada, during Six Months Ended June, 1938. Pp. 32. Price 25c. Dominion Bureau of Statistics, Ottawa.

The Asbestos Industry in Canada, 1937. Dominion Bureau of Statistics, Ottawa. Pp. 13. Price 15c.

Nickel, Copper Mining, Smelting and Refining Industry in Canada, 1937. Dominion Bureau of Statistics, Ottawa. Pp. 12. Price 25c. Also *The Salt Industry in Canada.* Pp. 9. Price 10c.

Mining Report for 1937 of the College of Commerce. In Swedish, with résumés in French. Swedish Official Statistics. Printed by K. L. Beckmans Boktryckeri, Stockholm, Pp. 70.

Geology of the Baguio Gold District. By Andrew Leith. Bulletin 9, Geological Survey Division, Bureau of Mines, Manila, P. I. Pp. 91 with maps.

Queensland, Australia. Annual report of the Under Secretary for Mines for the year 1937. Brisbane, Australia.

South Australia. Mining Review for half year ended Dec. 31, 1937. Bulletin 67, Department of Mines. Government Printer, Adelaide. Pp. 120.

New South Wales. Annual Report of Department of Mines, 1937. Pp. 167. Obtainable from D. H. Paisley, Government Printer, Sydney, N. S. W., Australia.

South Africa. Department of Mines, Pretoria. Statistics for July, 1938.

Annual Report, 1937, Rhodesia Chamber of Mines, Inc. Bulawayo, Southern Rhodesia. Pp. 53.

Southern Rhodesia. The Geology of the Lower Unfuli Gold Belt, Hartley and Lomagundi Districts. By A. E. Phaup and F. O. S. Dobell. (Total production from 1891 to date, 408,517 oz. gold and 43,828 oz. silver.) Bulletin No. 34. Geological Survey, Salisbury, Southern Rhodesia. Pp. 150, plus maps. Price 5s. Postage abroad 4d.

Magnetic Prospecting in the Northern Part of Santa Catherina. By M. C. Malamphy, H. Capper A. de Souza, and I. C. do Amaral. In Portuguese. Bulletin 85. Geological and Mineralogical Service, Department of Agriculture, Rio de Janeiro, Brazil.

Geophysical Prospecting in the State of Parana. By Euzebio de Oliveira. In Portuguese. Geological and Mineralogical Service, Department of Agriculture, Rio de Janeiro, Brazil.

Summary of the

MARKETS

EXCEPT for a good volume of business in lead that came into the market as soon as the price was reduced to the basis of 4.75c., New York, December was more or less featureless. The wide spread between foreign and domestic copper held buying to a minimum here, but the price was maintained at 11.25c., Valley. Zinc, still suffering because of the reduction in the import duty, was depressed on the poor showing of the foreign quotation. The last day of the month brought an announcement from Washington stating that the price of 64.64c. on newly mined domestic silver would remain in force until June 30, 1939.

The *E. & M. J.* index number of nonferrous metal prices for December was 77.13, against 78.36 in the month previous. The reduction reflected lower monthly averages for lead, zinc, and tin.

On Dec. 7 it was announced in London that the foreign copper cartel reduced output, effective Dec. 15, to 105 per cent of the basic tonnages, and fixed the rate beginning Jan. 1 to 100 per cent. This was done to steady the market in the face of lessened buying abroad for consumption. The news served to support values in London, but the uplift was slight and failed to revive buying interest, particularly in the domestic trade. The November statistics showed that production in the United States had been stepped up too fast, and the industry now looks for some corrective action to bring production and consumption into line.

Lead became quite active after the price dropped to 4.75c., New York, and the quotation was raised on Dec. 19 to 4.85c.

E. & M. J. metal prices, summarized herewith for the preceding month, are also published weekly in "*E. & M. J. Metal Mineral Markets*" for those who need current information. Sample copy and subscription rates on request.

UNITED STATES MARKET

1938	Electrolytic Copper, Domestic (a)	Electrolytic Copper, Export (b)	Straits Tin, New York	Lead, New York	Lead, St. Louis	Zinc, St. Louis
Dec.						
1	11.025	10.075	46.200	5.00	4.85	4.50
2	11.025	10.000	45.850	5.00	4.85	4.50
3	11.025	9.975	45.850	5.00	4.85	4.50
5	11.025	9.875	46.000	5.00	4.85	4.50
6	11.025	9.875	46.250	4.85	4.70	4.50
7	11.025	10.025	46.500	4.85	4.70	4.50
8	11.025	10.025	46.125	4.85	4.70	4.50
9	11.025	9.975	45.850	4.75	4.60	4.50
10	11.025	9.950	45.950	4.75	4.60	4.50
12	11.025	9.950	46.000	4.75	4.60	4.50
13	11.025	9.950	46.000	4.75	4.60	4.50
14	11.025	9.950	46.000	4.75	4.60	4.50
15	11.025	10.025	46.350	4.75	4.60	4.50
16	11.025	10.075	46.000	4.75	4.60	4.50
17	11.025	10.075	46.000	4.75	4.60	4.50
19	11.025	10.050	46.000	4.85	4.70	4.50
20	11.025	10.050	46.000	4.85	4.70	4.50
21	11.025	10.050	46.000	4.85	4.70	4.50
22	11.025	10.025	46.250	4.85	4.70	4.50
23	11.025	10.025	46.350	4.85	4.70	4.50
24	11.025	10.025	46.350	4.85	4.70	4.50
26	Holiday	Holiday	Holiday	Holiday	Holiday	Holiday
27	11.025	10.075	46.350	4.85	4.70	4.50
28	11.025	10.075	46.500	4.85	4.70	4.50
29	11.025	10.125	46.700	4.85	4.70	4.50
30	11.025	10.150	46.650	4.85	4.70	4.50
31	11.025	10.150	46.600	4.85	4.70	4.50
			AVERAGE FOR MONTH			
	11.025	10.023	46.180	4.842	4.692	4.500
Dec.			**AVERAGES FOR WEEK**			
7	11.025	9.971	46.108	4.950	4.800	4.500
14	11.025	9.967	45.988	4.767	4.617	4.500
21	11.025	10.054	46.058	4.800	4.650	4.500
28	11.025	10.045	46.360	4.850	4.700	4.500
Dec.			**CALENDAR WEEK AVERAGES**			
3	11.025	10.008	45.950	5.017	4.867	4.542
10	11.025	9.954	46.113	4.842	4.692	4.500
17	11.025	10.004	46.058	4.750	4.600	4.500
24	11.025	10.038	46.158	4.850	4.700	4.500
31	11.025	10.115	46.560	4.850	4.700	4.500

SILVER, GOLD, AND STERLING EXCHANGE

NEW YORK AND LONDON

1938	Sterling Exchange, "Checks"	Sterling Exchange, "90-day demand"	Silver, (c) New York	Silver, London	Gold, London	Gold, (d) United States
Dec.						
1	4.673750	4.656250	42.750	20.0625	148s 6½d	$35.00
2	4.673750	4.652500	42.750	20.1875	148s 11d	35.00
3	4.685000	4.662500	(e)	20.1250	148s 7½d	35.00
5	4.692500	4.671250	42.750	20.0000	148s 3½d	35.00
6	4.690000	4.668750	42.750	20.1250	148s 1d	35.00
7	4.685000	4.663750	42.750	20.0625	148s 5d	35.00
8	4.667500	4.646250	42.750	20.1875	148s 11d	35.00
9	4.665000	4.641250	42.750	20.0625	149s	35.00
10	4.672500	4.650000	(e)	20.0000	148s 11d	35.00
12	4.663750	4.641250	42.750	20.1250	148s 10½d	35.00
13	4.663750	4.641875	42.750	20.1875	149s 1½d	35.00
14	4.668750	4.646875	42.750	20.1250	149s	35.00
15	4.673750	4.651250	42.750	20.0625	148s 8d	35.00
16	4.670000	4.647500	42.750	19.9375	148s 8½d	35.00
17	4.673750	4.650000	(e)	20.0000	148s 11d	35.00
19	4.672500	4.649375	42.750	20.1250	148s 8d	35.00
20	4.666250	4.643750	42.750	20.1250	148s 10d	35.00
21	4.658750	4.635000	42.750	20.0625	149s 3d	35.00
22	4.662500	4.637500	42.750	20.0625	149s	35.00
23	4.662500	4.637500	42.750	20.2500	148s 11d	35.00
24	4.662500	4.633750	(e)	20.1875	149s 1d	35.00
26	Holiday	Holiday	Holiday	Holiday	Holiday	Holiday
27	4.660000	4.632500	42.750	Holiday	Holiday	35.00
28	4.660000	4.632500	42.750	20.0000	149s	35.00
29	4.656250	4.635000	42.750	19.9375	149s ½d	35.00
30	4.650000	4.628750	42.750	20.0000	149s 5½d	35.00
31	4.637500	4.613750	(e)	20.0625	149s 7½d	35.00
Average for Mo.	4.66798	.....	42.750	20.083	.....	35.00

AVERAGES FOR WEEK

Dec.						
7	4.68333	.....	42.750	.....	.....	.....
14	4.66688	.....	42.750	.....	.....	.....
21	4.66917	.....	42.750	.....	.....	.....
28	4.66150	.....	42.750	.....	.....	.....

Calendar week averages: New York Silver, Dec. 3rd, 42.750; 10th, 42.750; 17th, 42.750; 24th, 42.750; 31st, 42.750.

(e) Not quoted; Saturday.

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis add 0.225c. per pound, the average differential for freight and delivery charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Most sales in the foreign market are made on the basis of c.i.f. usual ports of destination—Hamburg, Havre, and Liverpool. The c.i.f. basis commands a premium of 0.325c. per pound above our refinery quotation.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East and Middle West in nearly all instances command a premium of 1c. per pound over the current market for Prime Western but not less than 1c. over the *Engineering and Mining Journal's* average quotation for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly mined domestic. Under Executive order effective Jan. 1, 1938, the U. S. Government's price on newly mined domestic silver was established at 64.64c. Handy & Harman's quotation for domestic silver, 999 fine, was 64⅛c. per ounce throughout December.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in domestic and imported ore or concentrate is at 99.75 per cent of the price quotated by the Treasury, which at present is equal to $34.9125 per ounce.

PRICES OF METALS • MISCELLANEOUS QUOTATIONS

LONDON MARKET

1938	COPPER			TIN		LEAD				ZINC			
	Standard		Electro	Standard		Spot		3 months		Spot		3 months	
Dec.	Spot	3 months	Bid	Spot	3 months	Buyers	Sellers	Buyers	Sellers	Buyers	Sellers	Buyers	Sellers
1	43.5000	43.7500	49.0000	215.0000	216.0000	15.6875	15.7500	15.8750	15.9375	13.6250	13.6875	13.8750	13.9375
2	43.0625	43.2500	48.5000	214.0000	214.7500	15.4375	15.5000	15.6250	15.6875	13.5000	13.5625	13.6875	13.7500
5	42.0625	42.3125	47.7500	212.7500	213.7500	15.1875	15.2500	15.3750	15.4375	13.2500	13.3125	13.4375	13.5625
6	42.2500	42.5000	48.0000	213.5000	214.2500	15.1250	15.1875	15.3125	15.3750	13.4375	13.5000	13.6250	13.6875
7	43.3750	43.6250	49.2500	215.0000	215.7500	15.1250	15.1875	15.3125	15.3750	13.6875	13.7500	13.8750	13.9375
8	43.1250	43.3750	48.7500	214.2500	215.0000	14.9375	15.0000	15.1250	15.1875	13.3750	13.4375	13.6250	13.6875
9	42.8750	43.1250	48.7500	213.3750	214.2500	14.8125	14.8750	15.0000	15.0625	13.3750	13.4375	13.6250	13.6875
12	43.0625	43.3125	48.7500	213.8750	214.7500	14.8750	15.0000	15.1250	15.1875	13.6250	13.6875	13.8125	13.8750
13	43.0000	43.2500	48.5000	214.2500	215.2500	14.6875	14.7500	14.9375	15.0000	13.5625	13.6250	13.8125	13.8750
14	43.0000	43.2500	48.5000	214.0000	215.0000	14.6250	14.6875	14.8125	14.8750	13.6250	13.7500	13.8750	13.9375
15	43.6875	43.9375	49.0000	215.2500	216.2500	15.1250	15.1875	15.3125	15.3750	13.7500	13.8125	13.9375	14.0000
16	43.6250	43.8125	49.0000	214.1250	215.2500	15.0000	15.0625	15.1875	15.2500	13.7500	13.8125	13.9375	14.0000
19	43.4375	43.6875	49.2500	213.5000	214.6250	15.0000	15.0625	15.1250	15.1875	13.5625	13.6250	13.6875	13.7500
20	43.6875	43.8750	49.5000	213.7500	215.0000	14.9375	15.0625	15.1250	15.1875	13.6250	13.6875	13.7500	13.8125
21	44.0000	44.1875	49.5000	214.0000	215.1250	15.1250	15.2500	15.3125	15.3750	13.8750	13.9375	13.9375	14.0625
22	43.8750	44.1250	49.5000	214.5000	215.5000	15.0625	15.1250	15.2500	15.3125	14.0625	14.1250	14.0625	14.1250
23	43.9375	44.2500	49.2500	215.0000	216.2500	15.1250	15.2500	15.3125	15.3750	13.9375	14.0625	14.0000	14.1250
26	Holiday	Holiday	Holiday	Holiday	Holiday	Holiday	Holiday	Holiday	Holiday	Holiday	Holiday	Holiday	Holiday
27	Holiday	Holiday	Holiday	Holiday	Holiday	Holiday	Holiday	Holiday	Holiday	Holiday	Holiday	Holiday	Holiday
28	44.0625	44.3125	49.2500	215.3750	216.5000	14.8750	14.9375	15.0000	15.0625	13.9375	14.0000	13.9375	14.0000
29	44.4375	44.7500	49.7500	216.5000	217.7500	15.1875	15.2500	15.2500	15.3125	13.8125	13.9375	13.9375	14.0000
30	44.5000	44.7500	50.0000	217.0000	218.0000	15.4375	15.5000	15.5000	15.5625	14.0000	14.2500	14.0625	14.1250
Average for month...	43.428	.....	48.988	214.450	.....	15.106		15.275		13.709		13.861	

Prices for lead and zinc are the official prices for the first session of the London Metal Exchange; prices for copper and tin are the official closing buyers prices. All are in pounds sterling per long ton of 2,240 lb.

CURRENT PRICES — MISCELLANEOUS METALS, ORES, AND NON-METALLIC MINERALS

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated

(Jan. 3, 1939)

MISCELLANEOUS METALS

Aluminum, ingot, 99 plus per cent, lb	20c.
Antimony, domestic, spot, lb	11.750c.
Bismuth, ton lots, lb	$1.05
Cadmium, lb	60@85c.
Calcium, lb., ton lots 97 @ 98 per cent	75c.
Chromium, 97 per cent grade, lb	85c.
Nickel, electrolytic cathodes, lb	35c.
Magnesium, 99.8 per cent, carloads, lb	30c.
Palladium, troy oz	$24.00
Platinum, (Official quotation) troy oz	$34.00
Quicksilver, flask of 76 lb., 100 flasks or more	$77.00@$78.00
Radium, mg. radium content	$40.00
Selenium, 99.5 per cent, lb	$1.75
Silicon, minimum 97 per cent, spot, lb	16.50c.
Tellurium, lb	$1.75
Thallium, 100 lb. or more, lb	$6.50
Titanium, 96 to 98 per cent, lb	$5.00

METALLIC ORES

Beryllium Ore, f.o.b. mines, ton	$30.00@$35.00
Chrome Ore, 48 @ 50 per cent, c.i.f. Atl. ports, long ton	$22.00@$23.00
Iron Ore, Lake Superior, Lower Lake ports, long ton:	
Old Range bessemer	$5.25
Mesabi bessemer	$5.10
Old Range non-bessemer	$5.10
Mesabi, non-bessemer	$4.95
Lead (Galena) 80 per cent, Joplin, Mo., ton	$54.38
Manganese Ore, c.i.f. Atlantic ports, long ton unit:	
52 @ 55 per cent	30c.
50 @ 52 per cent	28@30c.
44 @ 48 per cent	25c.
Molybdenum Ore, 90 per cent, per lb. of contained MoS_2	45c.
Tungsten Ore, per unit of WO_3:	
Chinese, 65 per cent, duty paid	$20.00
Domestic, 65 per cent and upward	(a)$17.00@$19.00
Vanadium Ore, per lb. of contained V_2O_5	27½c.
Zinc, Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton.	$29.00

(a) Prices at mines, small lots, usually several dollars less.

METALLIC COMPOUNDS

Arsenious Oxide (arsenic) lb	3c
Cobalt Oxide, 70 @ 71 per cent, lb	$1.67@$1.77
Copper Sulphate, 100 lb	$4.50
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb	$1.42
Sodium Sulphate, bulk, ton	$13.00@$15.00

ALLOYS

Beryllium Copper, master alloy, 2.5 to 3 per cent Be, per lb. of contained Be	$23.00
Ferrochrome, 65 @ 70 per cent chromium, 4 @ 6 per cent carbon, lb	10½c.
Ferromanganese, 78 @ 82 per cent, gross ton	$92.50
Ferromolybdenum, 55 @ 65 per cent Mo. lb. of Mo contained.	95c
Ferrosilicon, 50 per cent, gross ton	$69.50
Ferrotungsten, 75 @ 80 per cent, lb. of W contained	$1.60

NON-METALLIC MINERALS

Asbestos, f.o.b. mines, ton:	
Canadian (Quebec)	
Crude No. 1	$700@$750
Crude No. 2	$150@$350
Spinning fibers	$110@$200
Paper stock	$40@$45
Shorts	$12@$16.50
Vermont	
Shingle stock	$57
Paper stock	$40
Cement stock	$25
Barytes, long ton:	
Georgia, crude	$7.00
Missouri, 90 per cent $BaSO_4$, less than 1 per cent iron	$6.00@$7.00
Bauxite, long ton:	
Domestic, chemical, 55 @ 58 per cent	$6.00@$7.00
Domestic, abrasive, 70 @ 84 per cent	$12.50@$15.00
Dalmatian, 50 @ 55 per cent	(a)$6.50@$7.50
French, 56 @ 59 per cent	(a)$7.50@$8.50
China Clay, f.o.b. mines, ton:	
South Carolina and Georgia, No. 1, bulk	$6.75@$8.00
Delaware, No. 1	$14.50
Feldspar, bulk, ton:	
Potash feldspar, 200 mesh	$17.00
Glass-spar, white, 20 mesh	$11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85-5 per cent, all rail movement, ton	$18.00
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00@$14.00
Magnesite, per ton:	
Dead-burned, f.o.b. California	$25.00
Dead-burned, f.o.b. Washington	$22.00
Mica, per lb., North Carolina, No. 1 and 2 quality:	
1½ x 2 in	15@40c.
2 x 2 in	30@60c.
3 x 3 in	75@$1.20
3 x 4 in	$1.00@$1.40
4 x 6 in	$2.00@$2.50
White, ground, 70 mesh, ton	$60.00@$80.00
Ocher, Georgia, ton	$19.00@$22.00
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports	(a) 12@12½c.
Silica, in bags, 325 mesh, ton	$18.00@$40.00
Sulphur, Texas mines, long ton	$16.00
Talc, f.o.b. works, ton:	
New York, double air-floated, 325 mesh	$12.00@$15.00
New Jersey, mineral pulp	$8.00@$10.00
Vermont, extra white, 200 mesh	$9.00@$9.50
Tripoli, Missouri, ton:	
40 mesh, cream colored	$14.50
200 mesh, cream colored	$26.00

(a) Nominal

IRON AND STEEL

Pig Iron, Valley furnaces, gross ton:	
Bessemer	$21.50
Basic	$20.50
No. 2 Foundry	$21.00
Steel, base prices, Pittsburgh:	
Billets, gross ton	$34.00
Structural shapes, 100 lb	$2.10
Bars, 100 lb	$2.25

Monthly and Yearly

AVERAGE PRICES

SILVER AND STERLING EXCHANGE

	New York		London Spot		Sterling Exchange	
	1937	1938	1937	1938	1937	1938
January	44.913	44.750	20.734	19.895	490.670	499.895
February	44.750	44.750	20.083	20.159	489.307	501.722
March	45.130	44.446	20.677	20.088	488.412	498.394
April	45.460	42.750	20.740	18.880	491.524	498.046
May	45.025	42.750	20.346	18.731	493.835	496.673
June	44.818	42.750	20.022	18.945	493.404	495.772
July	44.750	42.750	19.986	19.356	496.582	492.855
August	44.750	42.750	19.848	19.389	498.043	488.044
September	44.750	42.750	19.889	19.300	495.145	480.240
October	44.750	42.750	19.942	19.613	495.395	476.785
November	44.750	42.750	19.707	19.834	499.467	470.587
December	44.750	42.750	18.835	20.083	499.510	466.798
Year	44.883	43.225	20.067	19.523	494.275	488.818

New York quotations for silver other than newly-mined domestic, cents per ounce troy, 999 fine. London, pence per ounce sterling silver 925 fine. Sterling exchange (pound sterling) in cents.

COPPER

	F.O.B. Refinery, Electrolytic				London Spot			
	Domestic		Export		Standard		(a) Electrolytic	
	1937	1938	1937	1938	1937	1938	1937	1938
January	12.415	10.198	12.112	9.908	51.497	41.387	56.288	45.387
February	13.427	9.775	13.828	9.525	59.225	39.597	64.013	43.563
March	15.775	9.775	16.590	9.496	72.339	39.772	76.167	43.582
April	15.121	9.775	14.692	9.443	62.506	39.306	66.614	43.408
May	13 775	9.375	13.999	8.801	61.118	36.668	63.684	40.852
June	13.775	8.775	13.492	8.500	55.696	35.235	61.409	39.417
July	13.775	9.585	13.817	9.573	56.412	39.744	62.807	44.405
August	13.775	9.900	13.926	9.844	57.143	40.591	63.595	45.909
September	13.530	10.028	12.984	9.943	52.989	41.864	58.966	47.148
October	11.838	10.760	11.207	10.713	45.384	45.646	50.619	51.190
November	10.797	11.025	9.850	10.569	39.321	45.244	44.023	51.080
December	10.006	11.025	9,714	10.023	39.946	43.428	43.886	48.988
Year	13.167	10.000	13.018	9.695	54.465	40.707	59.339	45.411

New York quotations, cents per pound. London, pounds sterling per long ton, (a) Bid quotation.

LEAD

	New York		St. Louis		London			
	1937	1938	1937	1938	1937 Spot	1937 3 Mos.	1938 Spot	1938 3 Mos.
January	6.000	4.870	5.850	4.720	27.272	27.150	16.135	16.253
February	6.239	4.632	6.089	4.482	28.319	28.328	15.402	15.525
March	7.190	4.500	7.040	4.350	33.027	32.979	15.992	16.075
April	6.175	4.500	6.025	4.350	26.014	25.878	15.579	15.623
May	6.000	4.400	5.850	4.250	24.000	23.891	14.210	14.376
June	6.000	4.148	5.850	3.998	22.878	22.759	13.969	14.012
July	6.000	4.882	5.850	4.732	23.932	23.703	14.921	15.034
August	6.452	4.900	6.302	4.750	22.606	22.670	14.371	14.480
September	6.400	4.998	6.250	4.848	20.990	21.044	15.249	15.401
October	5.740	5.100	5.590	4.950	18.259	18.318	16.173	16.313
November	5.033	5.091	4.883	4.941	16.706	16.714	16.088	16.223
December	4.875	4.842	4.725	4.692	15.905	15.994	15.106	15.275
Year	6.009	4.739	5.859	4.589	23.326	23.286	15.266	15.383

New York and St. Louis quotations, cents per pound. London pounds sterling per long ton.

TIN

	Straits New York		Standard, Spot London	
	1937	1938	1937	1938
January	50.925	41.548	229.350	183.619
February	52.010	41.373	233.750	183.144
March	63.043	41.219	282.988	183.473
April	59.172	38.430	267.136	168.612
May	55.651	36.885	250.645	162.693
June	55.851	40.376	249.852	177.429
July	59.245	43.428	263.540	192.542
August	59.465	43.276	264.595	192.966
September	58.675	43.369	258.943	193.733
October	51.654	45.263	223.869	206.911
November	43.299	46.262	190.477	213.909
December	43.051	46.180	190.449	214.450
Year	54.337	42.301	242.133	189.457

New York quotations cents per pound. London, pounds sterling per long ton.

ZINC

	St. Louis		London			
	1937	1938	1937 Spot	1937 3 Mos.	1938 Spot	1938 3 Mos.
January	5.847	5.000	21.153	21.281	14.994	15.173
February	6.465	4.813	25.122	25.322	14.408	14.589
March	7.381	4.417	33.188	33.405	14.364	14.477
April	7.010	4.141	26.216	26.344	13.729	13.919
May	6.750	4.042	23.092	23.365	12.682	12.869
June	6.750	4.131	21.409	21.528	12.890	13.104
July	6.923	4.745	22.568	22.693	14.144	14.371
August	7.192	4.750	24.140	24.290	13.467	13.675
September	7.190	4.846	21.406	21.607	14.040	14.246
October	6.085	5.012	17.722	17.955	15.083	15.232
November	5.630	4.924	15.808	15.970	14.366	14.550
December	5.010	4.500	15.274	15.429	13.709	13.861
Year	6.519	4.610	22.258	22.432	13.990	14.172

St. Louis quotations, Prime Western, cents per pound. London, pounds sterling per long ton.

CADMIUM AND ALUMINUM

	Cadmium		Aluminum	
	1937	1938	1937	1938
January	90.000	117.500	19.500	20.000
February	90.000	117.500	19.500	20.000
March	101.667	117.500	20.000	20.000
April	105.000	102.500	20.000	20.000
May	105.000	102.500	20.000	20.000
June	130.962	102.500	20.000	20.000
July	142.500	102.500	20.000	20.000
August	142.500	99.722	20.000	20.000
September	142.500	84.000	20.000	20.000
October	142.500	80.000	20.000	20.000
November	142.500	77.717	20.000	20.000
December	132.888	72.500	20.000	20.000
Year	122.335	98.037	19.917	20.000

Aluminum in cents per pound, 99 plus per cent grade. Cadmium, cents per pound, average of producer's and plater's quotations.

ANTIMONY, QUICKSILVER, AND PLATINUM

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1937	1938	1937	1938	1937	1938
January	14.130	13.750	90.250	79.240	50.400	36.000
February	14.563	13.750	91.000	76.455	64.364	36.000
March	16.375	13.750	91.778	72.444	58.000	36.000
April	16.043	13.654	92.000	71.019	58.000	36.000
May	14.830	12.460	95.520	74.640	54.800	33.400
June	14.702	11.731	96.654	80.731	53.000	33.231
July	14.803	11.030	93.904	76.860	50.115	36.000
August	15.327	10.880	91.423	75.500	51.000	37.000
September	16.555	11.310	89.020	74 420	51.000	39.000
October	16.935	12.060	86.140	73.480	48.560	37.960
November	15.848	12.250	83.435	74.065	43.652	36.217
December	14.144	11.567	81.038	76.769	38.385	34.000
Year	15.355	12.349	90.180	75.469	51.773	35.901

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce troy.

PIG IRON

	Bessemer		Basic		No. 2 Foundry	
	1937	1938	1937	1938	1937	1938
January	21.50	24.50	20.50	23.50	21.00	24.00
February	21.50	24.50	20.50	23.50	21.00	24.00
March	24.20	24.50	23.20	23.50	23.70	24.00
April	24.50	24.50	23.50	23.50	24.00	24.00
May	24.50	24.50	23.50	23.50	24.00	24.00
June	24.50	23.73	23.50	22.73	24.00	23.23
July	24.50	20.50	23.50	19.50	24.00	20.00
August	24.50	20.50	23.50	19.50	24.00	20.00
September	24.50	20.50	23.50	19.50	24.00	20.00
October	24.50	21.50	23.50	20.50	24.00	21.00
November	24.50	21.50	23.50	20.50	24.00	21.00
December	24.50	21.50	23.50	20.50	24.00	21.00
Year	23.975	22.686	22.975	21.686	23.475	22.186

Iron in dollars per long ton. F. o. b. Mahoning and Chenango Valley furnaces.

PERSONAL ITEMS

Merle H. Guise was in New York recently.

A. W. Allen has left California for Costa Rica.

H. I. Altshuler has gone to Bolivia on consultation work.

George J. Young was a welcome visitor to New York at the close of the year.

Richard H. Vail, of York, S. C., was in New York early in January.

W. C. Page has been appointed general manager of Trepca Mines in Yugoslavia, succeeding **S. A. Howie,** deceased.

John G. Baragwanath, president of Pardners Mines Corporation, recently returned from abroad to New York.

E. R. Borcherdt, research engineer for Anaconda and subsidiary companies, was in New York early in January.

G. C. Earl has been appointed chief engineer of Utah Copper Company, succeeding H. C. Goodrich, deceased.

Victor Mann, assistant underground superintendent of Mount Isa Mines, Ltd., is visiting New Guinea.

Philip R. Bradley, Jr., recently examined a mine property near Tonopah, Nev., returning to his San Francisco office.

Joe Scotty is assistant mill superintendent for Itogon Mining Company, Itogon, Mountain Province, Philippine Islands.

G. L. Ditchburn, assistant general manager of Emperor Mines, Ltd., Fiji, left on Nov. 17 to visit the United States and Canada.

W. L. McFarland, metallurgist, has been appointed mill superintendent at the Rawhide mine, near Emigrant Gap, Calif.

Walfred Been, mining engineer for Patiño Mines & Enterprises, recently arrived in New York for an extensive vacation.

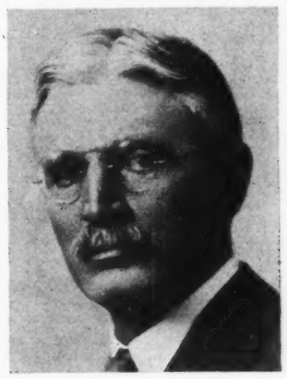
Fred Wise, superintendent for the Getchell Mine, Inc., in eastern Humboldt County, Nev., has been in Reno and San Francisco.

Lysle E. Shaffer, mining engineer, of Miami, Ariz., has gone to Honduras to investigate placer ground along the Guayape River.

Frank W. Griffin, of the staff of the International Mining Corporation, has returned to the United States from Colombia.

James A. Hill, of New York, has been elected president of the Illinois Zinc Company, succeeding **L. E. Wemple,** who is retiring.

Clinton H. Crane, president of St. Joseph Lead Company, was tendered a dinner by his associates on Dec. 12, at the Racquet and Tennis Club, New York, to celebrate his 25th anniversary as head of the company. A warm tribute was paid to Mr. Crane by those present for



CLINTON H. CRANE

his executive ability and leadership that has raised the company into the position of the largest lead producer in the country. Before taking over the leadership of St. Joseph Lead Company in 1913, Mr. Crane, who is a naval architect of note, was a member of the firm of Tams, Lemoine & Crane, naval architects. When he joined the lead company, the yearly sales of lead by St. Joe amounted to about 80,000 tons, which contrasts with sales of close to 222,000 tons in 1929. Mr. Crane received the William Lawrence Saunders medal in 1936 for distinguished achievement in the successful development and operation of low-grade lead mines. He is president of the Lead Industries Association and during the World War was head of the Lead Industries Board.

Livingston Wright, formerly at Westford, Mass., is now assistant professor of mining engineering, University of Alaska, College, Alaska.

A. W. Dunham, of New York City, new president of the Treasure Gold Mining Company, of Idaho, is at the mine inspecting the work.

A. E. Williams recently resigned from the position of Government Assayer at Darwin, Northern Australia, and has been succeeded by **S. Bourke.**

E. Williams has been appointed general manager of Wattle Gully Gold Mines, N. L., Chewton, Vic., Australia, succeeding the late John Till.

Dr. John Herman, assayer and chemist, 771 Julian St., Los Angeles, Calif., has recently been elected president of the Los Angeles Mineralogical Society.

Tasker L. Oddie, former Nevada Governor and United States Senator, has been investigating gold-silver properties in Clark County, Nev., near Boulder dam.

J. O. Elton, president of the Mountain City Copper Company, has been spending some time at that company's Rio Tinto mine, in northern Elko County, Nev.

H. N. Burley, long engaged in engineering work in South America, is in charge of the Mill Canyon gold mine and cyanide mill for Greenan & Company, Inc.

Roy A. Hardy, consulting engineer for the Getchell Mine Inc., has acquired a large group of gold claims in the Adelaide district south of Golconda, in Humboldt County, Nev.

Julius G. Reeder, of Chicago, president of the Nevada United Gold Mining Company, has assumed charge of the company's Dome mine, in the McCoy district in Lander County, Nev.

Arthur D. Storke, managing director of Roan Antelope Copper Mines, Ltd., has been elected vice-chairman of the company, and also vice-chairman of Mufulira Copper Mines, Ltd.

Klem B. Gross has been appointed general manager of New Guinea Goldfields, Ltd., Wau, N.G. Mr. Gross was formerly assistant mill superintendent of Mount Isa Mines, Ltd.

John F. Emerson, formerly with the Golden Cycle Corporation at Victor, Colo., is engaged in surveying and geological work for clients who are developing gold deposits in southern Arizona.

Dr. George Sachs, a prominent European authority on physical metallurgy, will join the faculty of the Case School of Applied Science, Cleveland, Ohio, in February.

G. N. Helling writes to direct attention to the fact that his former position was incorrectly stated in the December issue of *E. & M. J.* He was, before going to Mina San Gerardo, San Ramon, Costa Rica, superintendent and assistant manager at Jabali mine, Chontales, Nicaragua. Opportunity to make correction is appreciated.

Dr. T. Wayland Vaughan, of Washington, D. C., senior geologist of the United States Geological Survey, was on Dec. 28 elected president of the Geological Society of America.

H. E. Allen, who has been associated with mining in both South and West Africa for a number of years, has been appointed general manager of Gold Selection Trust, replacing **A. H. Douw,** resigned.

Dr. C. O. Hutton, a graduate of the Otago University, who recently spent

two years at Cambridge, in research work, has been appointed petrologist to the New Zealand Geological Survey.

R. S. Russell, sales engineer of Broken Hill Associated Smelters Proprietary, Ltd., returned to Melbourne recently after a fifteen months' business visit to Great Britain, Europe, and the United States.

Walter A. Janssen, chemical and metallurgical consulting engineer, of Washington, D. C., has been appointed

WALTER A. JANSSEN

chief of the Metals and Minerals Division of the United States Department of Commerce, succeeding **R. L. Harding.**

R. M. Murray, general manager of Mount Lyell Mining & Railway Company, Ltd., has returned to his headquarters at Queenstown, Tas., after an extensive business trip overseas.

L. M. Abell, ore dressing investigator for the Council for Scientific and Industrial Research, Adelaide, Australia, has resigned his position to become research metallurgist for Mount Morgan, Ltd.

R. B. Mills, former chief experimentalist, has been appointed mill superintendent at the Roseberry, Tas., mill of Electrolytic Zinc Company of Australia Ltd. He is a graduate of the University of Tasmania.

R. J. Parker, prominently identified with the earlier activities at the Roan Antelope and Mufulira copper properties, has been appointed managing director of Consolidated African Selection Trust, operating Gold Coast mines, **G. R. Nicolaus** having resigned.

A. R. Gordon, consulting mining engineer, has returned to his headquarters in Washington, D. C., after a visit to Mariposa County, Calif., where he examined properties comprising the old Fremont Grant.

Carlos W. Van Law has left the staff of Buckhorn Mining Company, Buckhorn, Nev., and has gone to Bolivia to join the mining department of the American Smelting & Refining Company at the property of the Corocoro United Copper Mines, Ltd., at Corocoro.

John B. Canada, mining engineer, Nevada City, Calif., formerly associated with Hoge Development Company, has joined the staff of the Walker Mining Company at Walkermine, Plumas County, Calif.

John B. Matson, until recently foreman at the Big Canyon unit of Mountain Copper Company, Ltd., has left for British Columbia, where he has been appointed mine superintendent for the Wells Mining Corporation.

A. Clinton Decker, sanitary engineer of the Tennessee Coal, Iron & Railway Company, has been appointed a member of the executive committee of the Sanitary Engineering Division of the American Society of Civil Engineers. He succeeds **Chester G. Gillespie,** of Berkeley, Calif.

Dr. Waldemar T. Schaller has been awarded the 1938 Roebling Medal of the Mineralogical Society of America. Presentation of the medal was made at the annual luncheon of the Society on Dec. 28 last at the Waldorf-Astoria. Dr. Schaller is chief mineralogist of the United States Geological Survey at Washington, D. C.

Dr. H. E. Simpson has been appointed to the incumbency of the fellowship established at the Mellon Institute of Industrial Research, Pittsburgh, by the United States Gypsum Company, of Chicago, Ill.

Dr. Frederick N. Rhines and **Dr. R. F. Mehl,** of Carnegie Institute of Technology, have been designated to receive the Institute of Metals award for the outstanding paper published in metallurgical research. The certificates of award will be presented at the A.I.M.E. meeting in February.

L. M. Abell, of the ore-dressing research staff of the Adelaide School of Mines, has been appointed research metallurgist for Mount Morgan, Ltd., Mount Morgan, Q. Prior to taking up research work at Adelaide in 1936, Mr. Abell had been on the staff of the Consolidated M. & S. Company of Canada for eight years.

Prof. C. W. B. Jeppe, dean of engineering in the Witwatersrand University at Johannesburg, arrived in New York Dec. 24 with a group of 30 students of mining for a tour of the principal mining districts of the United States and Canada. He expects to sail from New York for London on Feb. 12 on the return to Africa.

Royal D. Gardner has resigned his position as manager of the Gold Hill Dredging Company, San Francisco, Calif., to become vice-president and mine manager for Consolidated Sierra Mining & Milling Corporation, which recently took an option on the Arizona Comstock holdings at Virginia City, Nev.

James D. Stewart, consulting engineer, Auburn, Calif., was recently injured severely in the Gold Run placer district when a carbide drum exploded as he approached it with a miner's lamp. Mr. Stewart is the owner of the Stewart gravel mines currently operated by Gold Run Consolidated Placers, Inc.

E. L. Oliver, president, Oliver United Filters, Inc., has been elected chairman of the San Francisco Section A.I.M.E. Other officers elected to serve with Mr. Oliver during 1939 include **Charles White Merrill,** vice-chairman; **C. M. Eye, H. W. Gould, R. Hawxhurst, Jr., R. A. Kinzie,** members of the executive committee, and **H. A. Sawin,** secretary-treasurer.

Rolland C. Allen, of Cleveland, Ohio, executive vice-president of Oglebay, Norton & Company, and known also as a geologist and mineral economist long identified with Iron Country industrial affairs, has become a member of the board of trustees of Battelle Memorial Institute, of Columbus, Ohio. Mr Allen was president of the A.I.M.E. in 1937.

J. Malcolm Newman was recently elected a director of Mount Morgan, Ltd., Queensland. Mr. Newman has been prominently associated with the development of the Malayan tin industry for many years and is managing director of Tableland Tin Dredging, Ltd., which is about to undertake large scale operations at Mount Garnet, Queensland, Australia.

Leverett Davis, vice-president and general manager of cornucopia Gold Mines, operating at Cornucopia, Ore., has been elected first president of the Oregon Mining Association, an organization formed last month by a large number of Oregon mining men, who have banded together to protect and safeguard their mutual interests. **D. Ford McCormick,** of Med-

LEVERETT DAVIS

ford, manager of Sterling Mines, Inc., was selected as vice-president, and **F. Whalley Watson,** consulting engineer of Portland, is secretary-treasurer pro tem.

G. B. O'Malley, senior lecturer in mining and metallurgy at Melbourne University, resigned at the end of 1938 to accept an appointment as assistant technical representative in Australia for North American Cyanamid, Ltd., and its associates—Cyanamid Products, Ltd., London, and American Cyanamid Company, New York.

Dorrco Doings in 1938

The past year has seen a type of "progress" that many regard as retrogression. The narrow escape from what the world thought was to be the beginning of "the next war" gave everyone a jolt from which we have not yet recovered.

Whatever our beliefs may be, we must give serious thought to the point made by Anthony Eden during his recent visit to New York. Ideologies, he said, are judged by their results. Those who believe that a democracy offers the greatest satisfaction to the human soul must utilize their best endeavors to assure that democracy offers as much spiritually and materially to its adherents as the other system.

It seems incredible that there should be built up any type of hatred—racial as abroad, or of classes as in this country—as a means of bettering the condition of any section of humanity. Yet just this is taking place today. I believe, however, that the further the pendulum swings in one direction the sooner it will start back in the other.

WESTPORT

During its first full year of operation, our new Westport Mill handled 20% more jobs than in 1937 and on these expended almost 50% more time and effort. 37 different projects came from countries outside the United States. Semi-commercial scale tests resulted in one of the world's largest sewage Distributor installations at Dallas, Texas; and another series of tests in the first combination Flocculator-Clarifier installation at Ypsilanti, Mich.

WORLD'S LARGEST DESILTING PLANT

At the All-American Canal Desilting Plant near Yuma, Arizona, 72-125 ft. dia. Dorr Clarifiers, providing 28 acres of settling area, will remove daily 70,000 tons of silt from 8 billion gallons of turbid, Colorado River water, at an expenditure of less than 400 horsepower.

CLASSIFICATION

The new fine grinding plant at The Hollinger, in Ontario, consisting of four Dorr FX Classifiers in closed circuit with low discharge ball mills, is attracting wide attention and will be the subject of an A. I. M. E. paper in February.

Our 1939 model Dorr FX's have rakes with higher lifts and 15% more raking capacity.

TONNAGE

The new sand preparation plant for the Grand Coulee High Dam uses our Hydroseparators, Classifiers and Bowl Classifiers for producing a final blended sand with the fineness modulus of 2.90 set by the Federal Engineers. It is the world's largest—50,000 tons of feed per 24 hours—and the Dorr FX's are raking 1000 tons per foot of width per day.

TRADE WASTE TREATMENT

One of our ADKA White Water Savealls in a Pennsylvania paper mill is not only preventing stream pollution, but is also saving 25 to 30 dollars a day, which will repay the cost in less than a year.

Our first installation for treating steel pickling liquors is expected to yield a crystal clear solution by removing 98% of the soluble sulfates and by oxidizing 98% of the ferrous salts.

CYANIDING

The Dorr Washing Type Thickener at Cactus Mines in California gave within ½ percent of the standard C. C. D. washing efficiencies, yet saved 64% in ground area and 25% in cost.

SANITATION

At Cedar Rapids, Iowa the use of Dorrco Flocculators on raw sewage ahead of sedimentation, without the use of chemicals, has shown 50% greater removals of suspended solids.

This year we have developed a number of units combining two operating steps in a single tank for small municipalities. The Clarigester combines clarification and digestion; the Claraetor, clarification and aeration; and the Squarex Clarifier, flocculation and clarification.

SUGAR

Petree & Dorr, our cane sugar affiliates, have introduced an improved cane sugar Clarifier in which the efficiency and capacity have been improved through preflocculating the feed and an improved distribution of feed to each compartment. Thickened mud is removed from each compartment by a new method which prevents its dilution with feed to other compartments.

ABROAD

In Japan we have supplied equipment for three aluminum plants; in the Philippines, Dorr Washers for the removal of primary slime at two cyanide mills; in South Africa and Brazil, two complete sewage plants—one at Capetown and the other at Campina Grande.

Our European Associates are providing complete aluminum plant equipment in Jugoslavia and India; two complete new gold mills of the cyanide type for Bulgaria and Colombia; a complete recausticizing plant for Montecatini in Italy; a large new sewage clarifier installation for the London County Council and dewaxing filters for four lubricating oil plants in Germany.

This was a stay-at-home year for me with only one trip through the West and none abroad. Much planning and work of a fundamental nature with our European associates has been done at home, extending the responsibility of the organization as a whole.

Visitors at the Westport Mill from 13 other countries and a closer bond with Petree & Dorr, our cane sugar associates, helped to draw us more firmly together. Angola, Australia, Martinique and Reunion have been added to the areas of the world visited this year by our staff.

From everywhere, technically if not politically, comes interest and cooperation. In the name of Dorr men everywhere, I send Christmas Greetings to friends wherever situated and trust that the clear breath of the New Year will blow away the phantasies hovering around us all during 1938.

John V. N. Dorr

570 Lexington Ave., New York

DORRCO

Denison Denny has succeeded his uncle, the late H. S. Denny, in the management of several Canadian mining enterprises. He has been elected president of Mentor Exploration & Development, Ltd.; Lapa Cadillac Gold Mining, Ltd.; Mooshla Gold Mines, Ltd.; and Sudbury Contact Mines, Ltd. He has also become managing director of Norgold Mines, Ltd., and Wiltsey Coghlan Mines, Ltd. Mr. Denny is a native of South Africa. He came to Canada in 1924.

J. Murray Riddell, of Duluth, Minn., assistant general manager of mines for Republic Steel, was elected chairman of the Minnesota section of the A.I.M.E. at the annual meeting held in Minneapolis on Dec. 13. **O. A. Sundness,** of Chisholm, Minn., chief engineer for the Snyder Mining Company, was elected vice-chairman; **S. E. Atkins,** of Duluth, was made secretary-treasurer; and the executive committee consists of **P. J. Harrison,** of Crosby, Minn.; **E. H. Comstock,** of Minneapolis; and **W. L. Taylor,** of Hibbing, Minn.

Reno H. Sales, chief geologist of the Anaconda Copper Mining Company, will receive the Penrose Medal of the Society of Economic Geologists at the annual dinner to be held at the Harvard Club, in New York, on Feb. 14. The medal is awarded at irregular intervals for "unusually original work in the earth sciences." Mr. Sales has attained high distinction in his career as a mining geologist, not only for his brilliant and comprehensive scientific work in the Butte district but also for the convincing way in which he has demonstrated the value of geology to the entire mining industry.

Cyrus Fisher Tolman, who retired from the geology department of Stanford University, where he had taught for 25 years, last June, was the guest of honor at a dinner given for him by alumni and students of the departments of mining and geology at the San Francisco Commercial Club on Nov. 17. A special feature of the occasion was the presentation to the University of a fund financing a scholarship to be known as the "John Tolman Memorial Scholarship in Economic Geology," in memory of Professor Tolman's son, who died last year, and in honor of Professor Tolman, who was asked to accept the position of chairman of the board to select students to receive the scholarship.

E. G. Hill has been appointed assistant to the general superintendent in charge of coordination at the Gary Works of the Carnegie-Illinois Steel Corporation. **F. E. Mooney** has been made assistant to the general superintendent, production, and **J. N. Quinlan,** assistant division superintendent, West mills. Starting his experience in 1913, Mr. Hill was employed by various mining and construction companies as miner, assistant mill superintendent, and mill superintendent until 1918, when he became an instructor of mining engineering at the Carnegie Institute of Technology. Two years later he went to the University of Pittsburgh as associate professor of metallurgy, and remained there until 1931, when he engaged in research work at the Mellon Institute. Since 1934 he has been director of research at the Lukens Steel Company.

OBITUARY

Charles S. Thomas, mining engineer and geologist, died recently in Monrovia, Calif., at the age of 61.

John G. Flynn, of Bisbee, Ariz., manager of Shattuck Denn Mining Corporation, died on Dec. 16 at the age of 60.

Sidney L. Shonts, mining engineer, San Jose, Calif., was one of the victims of the recent airplane accident at Point Reyes, Calif.

John Harrison Deming, one of the leaders in mining and financial circles of Salt Lake City, Utah, died on Dec. 9 last at Salt Lake. He was 76.

George Adam Engle, who first became interested in mining in Nevada in 1862, died at Long Beach, Calif., on Nov. 11, 1938, at the age of 94.

Dr. Porter William Shimer, chemist and metallurgist, discoverer of titanium carbide, died at Easton, Pa., on Dec. 7 at the age of 81.

George B. Lyman, mine superintendent of the Copper Queen branch of Phelps Dodge Corporation, at Bisbee, Ariz., died on Dec. 7 at the age of 49.

Roy Nelson Bishop, a retired mining man, who at one time operated the King Solomon mine, in Siskiyou County, Calif., died in San Francisco recently at the age of 60.

Dr. Arthur Clifford Veatch, geologist, formerly scientific adviser to the United States Department of Justice, died in Port Washington, Long Island, on Dec. 24. He was 60 years old.

William J. Chalmers, formerly a manufacturer of mining machinery and an associate of his father when the Allis-Chalmers Company was formed by the consolidation of several manufacturers of mining equipment, died in Chicago on Dec. 10 last. He was 86 years old.

Clyde H. Gardner, general superintendent of the Keystone-Alpha Mines, Inc., Chloride, Ariz., was killed in a powder accident on Nov. 17 near the Alpha mine at Stockton Hill, Mohave County, Ariz. The body was returned to the family home in Los Banos, Calif., for interment.

Arthur Forrest Flynt died suddenly at Modena, Utah, on Nov. 16. He was born in South Bend, Ind., in 1872, and educated in mining engineering at the University of Minnesota. He went to Old Mexico when just a young engineer as superintendent of a mine in Zacatacas. Later he operated mining properties in Mexico for his own account. For the past several years he had been working a gold property near Modena, Utah.

H. E. Vail died in Perth, Australia, on Oct. 15 at the age of 69 years. Mr. Vail came to Australia from California in 1903 and for five years was manager at Kalgoorlie for Bewick, Moreing & Company. From 1909 to 1928 he was general manager of Lake View & Star, Ltd., and later consulting engineer to that company and to Wiluna Gold Mines, Ltd. At the time of his death he was a director of a number of gold mining companies in Western Australia and a vice-president of the Western Australia Chamber of Mines.

▼ ▼ ▼

A LETTER

On Defining "Sink-and-Float"

The Editor:

I WRITE as president of two companies which have probably done more practical work on "sink-and-float" operation than any other engineering undertaking. I refer to Huntington, Heberlein & Company, Ltd., of London, and Colliery Engineering, Ltd., of Sheffield. Both are responsible for a number of important plants reaching outputs of up to 300 tons per hour and both have met with outstanding success in the cleaning of coal and the concentration of minerals.

We have used the expression "sink-and-float," but when we talk about the separating liquid we always call it "stable medium." Years ago, when we first started developing this process, we naturally examined all the various methods which had been tried up to then, and we found that in the final analysis the real issue was whether a stable or unstable medium should be used. Admittedly, one can obtain a certain amount of cleaning or concentration with an unstable medium in connection with upward currents, but when it comes to real high-class work, it is soon proved that no unstable medium is good enough, and we have entirely abandoned using it even if, from the outset, it would be far easier to work with an unstable medium.

We have, however, been successful in developing various methods whereby we can combine a "stable medium" with such viscosity as is permissible for any specific work, and, as will readily be understood, when you come to work with specific gravities of the stable medium topping the figure 3, then the question of viscosity becomes a most important one.

We are, thus, using the expressions "sink-and-float" for the process in which we use a "stable medium" of suitable "viscosity."

J. O. BOVING

Rush House,
Aldwych, London W. C. 2

What Metal Statistics Show

DOMESTIC MINE PRODUCTION of copper, lead, and zinc reached higher levels at the close of the year, when business in general was experiencing the usual year-end quiet period. Producers closely watched the decline of prices abroad during December, and there was apprehension lest stocks of domestic copper, which showed an increase of 2,189 tons during November, would threaten the 11.25c. price. Some in the industry believe production during the winter period will show a slight reduction, but statistics for December will again show an increase of stocks of refined copper. On Jan. 1 production abroad by the foreign group in the copper-control agreement was reduced from 105 per cent to 100 per cent of capacity. Sales of domestic copper during 1938 totaled 512,761 tons, against 517,971 tons in 1937 and 966,307 tons in 1936. The industry believes the outlook for copper is promising and that better business will develop early in the first quarter, as a result of an upward trend in the building and automobile industries and larger expenditures by the utilities and for national defense.

The Copper Institute's figures for October and November, in short tons, follow:

	Oct.	Nov.
Production, crude:		
U. S. mine	54,405	60,277
U. S. scrap, etc.	15,225	12,709
Foreign mine	101,604	112,573
Foreign scrap	13,887	13,069
Totals (a)	185,121	198,628
Production, refined:		
U. S. duty free	56,824	66,746
Foreign	110,401	111,064
Totals	167,225	177,810
Deliveries to customers, refined:		
U. S. domestic	69,827	51,297
U. S. exports (b)	12,778	13,260
Foreign	117,363	113,427
Totals	199,968	177,984
Stocks at end, refined:		
United States	267,299	269,488
Foreign	157,412	155,049
Totals	424,711	424,537

(a) Revised. (b) Duty free copper.

▶ LEAD—Stocks of lead are expected to show a moderate increase during December, according to some in the trade. Declining prices during that month were due to an intake problem experienced by lead smelters at a time when business was dull. On Dec. 19, however, buying suddenly started and the price rose from 4.75c. to 4.85c. New York. Early in January a higher price might easily have been established except for the irregular unexpected unsettlement in the pound sterling and the irregular London market, which continued to reflect the uncertain political situation abroad. Foreign statistics are not available in detail, but it is understood that the trend favors producer.

The October and November figures on refined lead, in short tons, are summarized as follows:

	Oct.	Nov.
Stock at beginning	131,353	117,476
Production:		
Domestic ore	27,968	35,958
Secondary and foreign	3,875	3,842
Totals	31,843	39,800
Domestic shipments	45,726	42,030
Stock at end	117,476	115,236

Lead refinery statistics as reported to the American Bureau of Metal Statistics for the first eleven months of 1938 follow:

	(a) Production	Shipments	Stock At End
Jan.	39,196	34,923	133,401
Feb.	34,869	30,135	138,134
March	36,436	31,052	143,511
April	39,291	25,952	156,715
May	32,977	25,098	164,636
June	35,028	35,048	164,554
July	31,488	40,409	155,631
August	25,547	38,343	142,868
Sept.	27,508	39,026	131,353
Oct.	31,843	45,726	117,476
Nov.	39,800	42,030	115,236

(a) Includes secondary and foreign.

The above table shows the steady improvement in the statistical position of lead since June, and prospects for the first quarter of 1939 are expected by the industry to show improvement.

▶ ZINC—The influence of the low zinc tariff in the recent Canadian trade agreement effective Jan. 1 continues to be felt in terms of lower prices for domestic zinc. Since Nov. 21 the price of zinc had dropped from 5.05c. to 4.50c. per pound St. Louis, and some mines in the Tri-State district and in Idaho have been forced to lay off men as a result of the drastic drop in prices.

Statistics of the Prime Western division, common grades only, for the first eleven months of 1938:

	Production	Shipments	Stock At End
January	24,865	13,500	40,699
February	21,755	14,223	48,231
March	22,404	21,634	49,001
April	20,868	11,790	58,079
May	20,537	13,949	64,667
June	14,657	12,649	66,675
July	13,869	16,689	63,855
August	13,962	20,288	57,529
September	14,167	19,486	52,210
October	15,833	17,911	50,132
November	17,013	19,842	47,303

Foreign and Domestic Copper Statistics

Following is a summary of the copper statistics reported by members of the Copper Institute, in short tons:

U. S. Duty Free Copper		Production Crude(a)	Production Refined	Deliveries to Customers Domestic	Deliveries to Customers Export	Deliveries to Customers Total	Refined Stocks(b)
June 30	1933	.....	.....	.....	.....	.....	600,340
Dec. 31	1933	.....	.....	.....	.....	.....	523,435
Year	1934	360,534	336,710	379,843	125,866	505,709	354,436
Year	1935	506,085	496,658	528,194	91,485	619,679	231,415
Year	1936	731,629	748,660	764,560	54,447	819,007	161,068
Year	1937	982,045	964,176	803,095	62,798	865,893	259,351
11 Mos.	1938	571,574	569,538	442,376	117,025	559,401	269,488
January	1938	58,760	70,487	24,881	5,824	30,705	299,133
February	1938	50,704	59,393	27,389	4,893	32,282	326,244
March	1938	56,199	61,117	33,434	11,142	44,576	342,785
April	1938	50,941	55,749	31,684	11,187	42,871	355,663
May	1938	49,125	47,300	28,044	5,110	33,154	369,809
June	1938	38,200	32,465	32,863	10,440	43,303	358,971
July	1938	31,155	35,596	41,249	13,348	54,597	339,970
August	1938	44,558	38,053	48,071	14,761	62,832	315,191
September	1938	(c)49,316	45,808	53,637	14,282	67,919	293,080
October	1938	69,630	56,824	69,827	12,778	82,605	267,299
November	1938	72,986	66,746	51,297	13,260	64,557	269,488
Foreign Copper							
June 30	1933	.....	.....	.....	.....	.....	166,377
Dec. 31	1933	.....	.....	.....	.....	.....	175,604
Year	1934	941,247	884,154	.....	.....	827,063	232,695
Year	1935	1,023,481	1,004,473	.....	.....	983,255	253,913
Year	1936	966,153	911,887	.....	.....	973,545	192,255
Year	1937	1,349,138	1,301,873	.....	.....	1,282,284	211,844
11 Mos.	1938	1,172,489	1,177,690	.....	.....	1,234,485	155,049
January	1938	108,621	103,815	.....	.....	108,823	206,836
February	1938	102,092	101,957	.....	.....	105,903	202,890
March	1938	105,643	108,704	.....	.....	114,127	197,467
April	1938	104,413	106,839	.....	.....	118,390	185,916
May	1938	107,199	102,044	.....	.....	103,413	184,547
June	1938	106,177	110,067	.....	.....	102,090	193,524
July	1938	96,635	103,887	.....	.....	113,185	183,226
August	1938	(c)103,735	110,855	.....	.....	114,748	179,333
September	1938	(c)96,841	108,057	.....	.....	123,016	164,374
October	1938	115,491	110,401	.....	.....	117,363	157,412
November	1938	125,642	111,064	.....	.....	113,427	155,049

(a) Mine or smelter production and custom intake including scrap (excludes Russia, Japan, Australia, and some miscellaneous production). (b) Stocks end of period at refineries, on consignment and in Commodity Exchange warehouses, but not including consumers' stocks at their plants or warehouses. (c) Corrected.

Note: Deliveries of "foreign copper" do not include domestic copper shipped abroad. The sum of foreign copper deliveries and exports of duty-free copper is the total quantity delivered abroad by member of the Copper Institute.

The first and fourth panels of a series of large murals by Irwin D. Hoffman that will appear in Treasure Mountain at the Golden Gate Exposition, San Francisco. The divisions in the first panel show earliest flint mining, the iron age and the bronze age with its crude smelting practice. Modern methods and equipment used in mining, milling, and smelting are portrayed on the right. The series will inform the visitor about mining through the ages and show what the industry is doing for civilization today

CALIFORNIA

Work on Narrows Debris Dam to Start Soon

New project has estimated storage capacity of 112,000,000 cu.yd.—Operations begin at Banner Mine—"Treasure Mountain," at Golden Gate Exposition, will be Mecca for the mining industry

▶ Contract for construction of the Narrows débris dam near Smartsville, Yuba County, has been awarded to the Arundel Corporation, of Baltimore, Md., and the L. E. Dixon Construction Company, of Los Angeles, according to a report from Sacramento. The firms recently submitted a joint low bid for $2,175,271, with materials for the dam to be furnished separately. Net storage capacity of the new dam is estimated at 112,000,000 cu.yd., and the cost of construction will be repaid by miners' operations over a period of twenty years. The dam is one of four planned for the Yuba, Bear, and American rivers by the United States Army engineers to allow a resumption of hydraulic mining which has been dormant for more than 50 years. Actual work is to start within 60 days. O. C. Hartman is resident engineer.

▶ The E. L. Cord interests have closed the Auburn Chicago mine, at Penryn, Placer County, after nearly five years of continuous operation, and the surface plant and machinery are being dismantled under the direction of L. K. Wilson, superintendent, for early transfer to the company's property at Silver Peak, Nevada. Milling was done in a 50-ton flotation plant, and the mine furnished work for about 50 men. A. N. Sweet is general manager for the Cord mining operations.

▶ Operations have started at the Banner mine, near Oroville, Butte County, taken over, together with the old Bumblebee property, now known as the Gold Stripe, by the Amosky Banner Consolidated Mines, organized recently by J. O. Jensen, of San Francisco. Plans include immediate rehabilitation of the 600-ft. Amosky inclined shaft, eventual reopening of the 1,000-ft. Banner vertical shaft, and connection of both shafts on the 400-ft. level. A vertical vein in the Gold Stripe mine is to be developed by a cross-cut to be extended from the main tunnel. The reduction plant rehabilitated recently can handle some 40 tons of ore a day. Frank L. Sizer, Hobart Building, San Francisco, is consulting engineer for the company.

▶ The mining exposition sponsored by Mining Exhibits, Inc., is gradually taking shape for the opening of the Golden Gate Exposition on Feb. 18, 1939. Construction on "Treasure Mountain" is proceeding according to schedule under direction of Lindgren & Swinerton, of San Francisco, contractors. On the surface of "Treasure Mountain" will be shown the different methods by which ore is extracted from the earth (hydraulic, dredging, open pit, and others), and stoping methods, maps, dioramas, and a series of murals showing the influence of mining upon civilization are to be features of the exposition. At one end of the mountain is a full-sized, three-compartment shaft with skip, cage, and fully equipped manway. No efforts are being spared to make the fair interesting, and the work done so far is reported to be so realistic that one is tempted to start mining in earnest.

▶ The old Pioneer mine, near Plymouth, Amador County, operated by the Associated Mining Company, is producing again. The company recently rehabilitated the property and erected a new surface plant consisting of a 60-ft. headframe, compressor and hoist house, change house, repair shop, office, and mill. Operations are on a two-shift basis at present, with about twenty men employed under the direction of B. C. Clark, superintendent.

▶ Wilbur Timm has a small crew at work at the Atlanta mine, near Kelsey, El Dorado County. The two-compartment shaft, now 135 ft. deep, is to be continued to 160 ft., to be followed by extensive exploration work.

▶ With the completion of a new dragline dredge on a gravel deposit near Folsom, the General Dredging Corporation, of Sacramento, has now three units active in the field. The dragline dredge operating at Mississippi Bar in the vicinity of Folsom is handling 5,000 yd. of gold-bearing gravel a day, and that near Weaverville, Trinity County, is treating 2,000 yd. daily. Executive officers of the corporation include W. H. Haines and O. J. Boucher, both of Sacramento, and J. O. Greenan.

▶ Shaft-sinking operations and general development work are in progress at the Alhambra mine, near Placerville, El Dorado County, with eighteen men employed under the direction of R. H. McGuire, superintendent. Early installation of a 25-ton milling plant is planned.

▶ Operating two draglines, a power shovel, and a washing plant mounted on tractors on a placer deposit along Butte Creek east of Chico, the Humphreys Gold Corporation is now mining 5,500 cu.yd. of gravel a day. The placer installation originally was operated on Clancy Creek, in Montana. D. G. Brown is general superintendent, and thirty men are employed.

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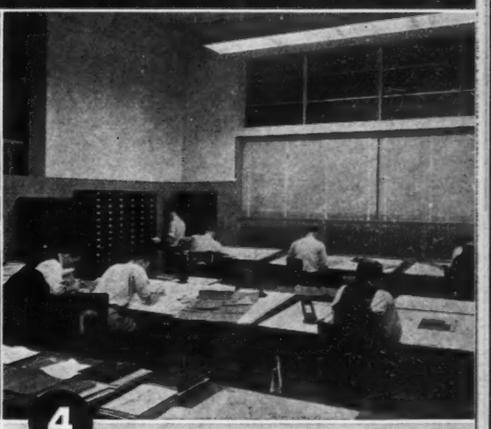

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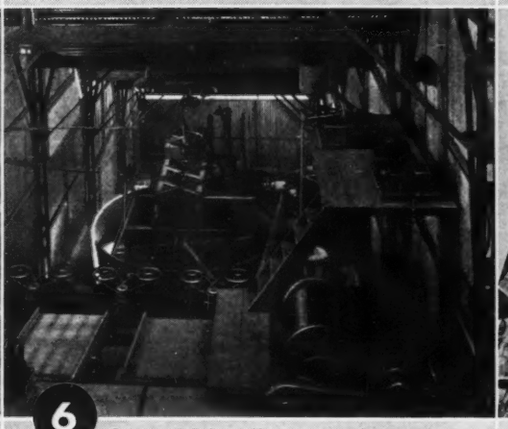

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▶CALIFORNIA

▶Alaska Juneau Gold Mining Company, P. R. Bradley, president, San Francisco, has taken an option on the old Harvard mine, at Jamestown, Tuolumne County, and has inaugurated a comprehensive sampling and development campaign. The property, which has been opened up to a depth of more than 1,800 ft., is said to have possibilities of developing into a large-tonnage, low-grade gold producer. Underground workings are open to the 500-ft. level. Facilities for assaying and air-generating equipment are being installed, and the development work planned will require the better part of a year, after which, if results are satisfactory, mine, surface, and mill machinery will be installed.

▶Operations have been resumed at the Oriental mine, near Alleghany, Sierra County, subleased recently to Florence V. Dickey, of Ojai, Calif., by F. F. Cassidy, of Grass Valley, who, until the death of his partner, Ray Hawkins, operated the property under lease. The actual owners are L. Kleinsorge, H. B. Drescher, George Gamble, and W. P. Walworth. It is understood that the sublease runs until 1944, carries an option to buy the mine for $800,000 on a royalty basis, and requires extensive development and milling of low-grade ore be part of the operation. The property has produced high-grade gold ore for years. Charles B. Forster is in charge of operations.

▶A 125-ton mill is to be installed at the Red Banks mine, near Bagby, Mariposa County, by F. W. Draper, the operator. Exploratory work has been carried on at the property for more than two years, and a substantial amount of ore is available for milling.

▶Fort Anne Mining Company has completed a 75-ton milling plant at its property near Volcano, Amador County. The mine is developed to a depth of 300 ft., and current underground activities include clearing out two stopes on the 40-ft. level. J. C. Nimmo and F. W. Kent, both of Los Angeles, and William Anderson, of San Diego, head the company.

▶With sufficient gravel available to assure steady operation, The Fiori Mining Corporation is preparing for extensive work on its holdings in the Placerville area. Installation of a 600-ft. pipe line, two hydraulic monitors, and an intake dam has been completed, and rehabilitation work on the 6-mile Steadman ditch is progressing rapidly. When completed, the ditch will be able to carry about 500 in. of water. Drifting along a known channel is to start next spring. E. R. Dathe is general superintendent.

▶The hull of one of the largest gold dredges in the world was launched on Dec. 20, near San Francisco, by the Yuba Manufacturing Company. When completed the dredge will be capable of digging about 115 ft. below and against a bank of 40 ft. or more. The hull, weighing 1,500 tons, was sent to the pond after smashing of a bottle of California champagne on the bow by Miss Peggy Perring, daughter of H. C. Perring, field superintendent of Yuba Consolidated Gold Fields. It measures 80x250 ft. and was erected in the record time of 30 days. The dredge will employ 18 cu.ft. buckets and is expected to be ready for operation in May, 1939.

Correction—The item on page 64 in the December issue relating to the Lava Cap Gold Mining Corporation removing itself from jurisdiction of N.L.R.B. by sending its concentrates to Selby, Calif., instead of Tacoma, Wash., is not correct, according to word from the corporation. Concentrates shipments to Tacoma were stopped at the request of the American Smelting & Refining Company as of Oct. 1, 1938, for economic reasons, since A.S.&R. could now treat the highly arsenical concentrates (produced by Lava Cap Corporation) at the Selby plant, in California, due to the erection of a 602-ft. stack, which was constructed in 1938.

NEVADA

Placer Mining Expands In Several Counties

Gold production from this source expected to increase during year—Old Black Hawk mine, at Aurora, reopened—Drilling program discloses more ore at Consolidated Coppermines

▶Most notable among developments of recent months in Nevada has been the expansion in placer mining, chiefly in Nye, Lander, Pershing, and Humboldt counties. At Manhattan the huge bucket-line dredge of the Manhattan Gold Dredging Company is reported treating upward of 10,000 cu.yd. of gravel daily, under direction of staff engineers of the Natomas Company, which owns something over 20 per cent of the $500,000 authorized capital stock. The dredge, the largest ever built in Nevada, is said to have a capacity of 14,000 cu.yd. per day. Unverified reports are to the effect that the company is considering construction of a second dredge of similar type.

▶A floating gold dredge with dragline feed is operated by the Mill Gulch Placer Mining Company in the Tenabo district, Lander County. William Keith Scott, of Reno, is president. Another dredge of around 5,000-cu.yd. capacity was completed recently by the Nevada Gold Dredging Company on placer claims formerly owned by the Ancient Gold Placers Company, east of Minden. Many small units, some with power-driven trommels and various gold-saving devices, are operating in the counties mentioned.

▶The old Black Hawk mine, at Aurora, Mineral County, one of Nevada's first boom camps, has been reopened by C. E. Kelsey and F. A. Junquist, who are completing construction of a flotation mill with equipment from a long-idle mill at the Basque mine, in Humboldt County, purchased by the partners. The Black Hawk was an important early-day gold producer.

▶A 200-ft. vertical shaft is being sunk by contractors on the Dan Tucker gold-silver mine, 30 miles east of Fallon, in Churchill County, acquired recently under option of purchase by Ira B. Joralemon, of San Francisco, and associates. Under the option the owners retained a central block with the main incline shaft, from which they have shipped some high-grade ore.

▶Churn drilling is continuing in the Morris Brooks area of Consolidated Coppermines, and the management is greatly encouraged by results. The rotary drill in the Emma Nevada section has been discontinued for the winter months. Churn drilling in the Morris Brooks section continues to disclose additional tonnages of ore. It is believed that the amount of new ore exceeds the tonnage extracted since operations were resumed on Jan. 1, 1937. From Jan. 1, 1937, to the end of 1938, around 2,800,000 tons have been mined. Precious-metal values indicated in the Morris Brooks area are somewhat higher than in the Emma Nevada area now being mined.

▶A 50-ton flotation mill on property of the Ohio Mines Corporation at Goldpoint, formerly Hornsilver, 30 miles south of Goldfield, has been running at capacity on gold-silver ore from the Orlean shaft, and the Townsite shaft has been opened lately to provide for increased production. Main offices are in Cincinnati, and Otto Dieckman, Jr., is manager.

▶James O. Greenan and Tasker L. Oddie have acquired jointly and are developing a cinnabar property in Humboldt County, 12 miles north of the Getchell mine.

▶Mines and leases in the vicinity of Battle Mountain shipped 50 carloads during November, about one-third of which was barite from deposits south of Valmy. In this area several large deposits of barite of high grade have been opened.

▶Numbers of lessees working in the Douglas district, six miles southwest of Mina, in Mineral County, have been shipping gold ore of uniformly high grade to the custom cyanide mill of the Dayton Consolidated Mines Company at Silver City. Some of the ore has been exceedingly rich, coming mostly from the veins branching from the main contact ore-channel on the Douglas property, controlled by Harry E. Springer, of Mina.

▶Twelve 20-ton trucks are delivering to the rail point at Elko around 240 tons of high-grade copper ore and flotation concentrate per day from the Rio Tinto mine of the Mountain City Copper Company, in northern Elko County. The company is joining with state and county agencies to keep the road open during the winter. Shipments are drawn in part from a 5,000-ton stockpile of concentrate at the mill.

▶The Mountain City Consolidated Copper Company, with large property adjoining the Rio Tinto mine, has resumed sinking its inside shaft with complete diesel-powered equipment purchased recently, and the shaft was said to be showing many seams of oxidized

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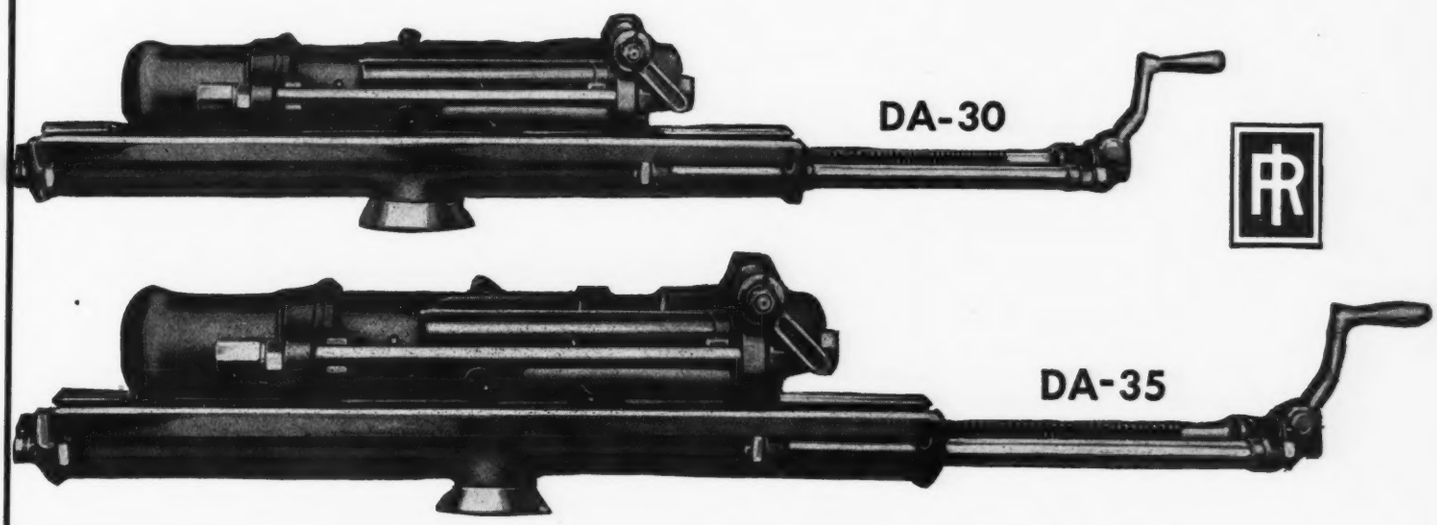

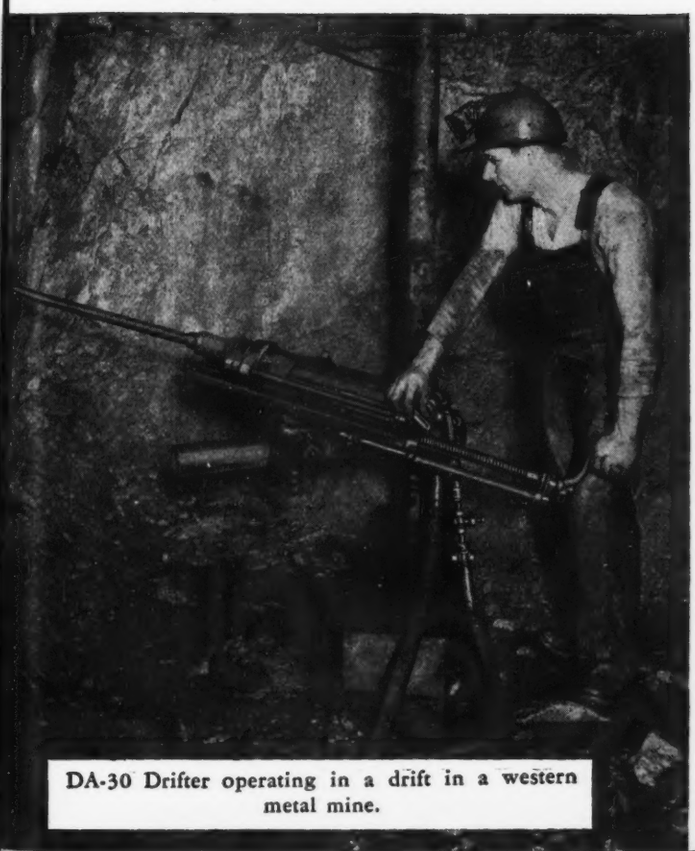

DA-30 Drifter operating in a drift in a western metal mine.

IT'S the great drilling speed that makes these new drifter drills such marvelous money savers. Out-of-pocket expenses for a shift are about the same, regardless of the drills used, hence, by selecting the machine that will turn out the greatest footage, a minimum cost per foot of hole is obtained.

We invite a comparison of the "DA" drifters with any drills you are now using. An investigation will show that the speed and efficiency of the "DA" line will enable you to make substantial savings. Each additional 5% more drill hole per shift gives you the price of a new drill.

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▶NEVADA

ore sampling as high as 32 per cent copper, although the shaft is still in the footwall country, 30 to 40 ft. from the ore-bearing zone extending from the Rio Tinto claims.

▶ Cost-cutting refinements in the cyanide mill and roasting plant of the Getchell Mine, Inc., in eastern Humboldt County, involve a means, designed by R. A. Hardy, consulting engineer, in collaboration with the mill staff, of piping hot air from the discharge end of the 100x7-ft. rotary furnace through all parts of the large cyanide mill, in which a minimum of 40 deg. F. has been maintained in freezing weather. Heat is distributed by natural draft, without application of power, the intake being around 100 ft. from the nearest release point in the mill structure. This method will reduce oil consumption in the heating of solution.

▶ Plans of the Copper Canyon Mining Company, with productive gold and copper properties south of Battle Mountain in Lander County, include the sinking of a main central shaft, several hundred feet from the present inadequate 350-ft. shaft, and construction of a mill. L. E. Whicher, of New York, active head of the company, was said to have applied for SEC registration with the purpose of financing.

▶ A final hearing has been set for early January by Judge Frank H. Norcross of the Federal District Court at Carson City on the application of James M. Leonard, trustee in bankruptcy for the Arizona Comstock Corporation, for permission to sell the mines and assets of that company to William N. Albee, of Detroit, for approximately $640,000.

UTAH

Work Resumed on Elton Tunnel

Bore is deflected in order to reach bedrock and avoid heavy water flow — Geyser Marion Gold Mining Company plans to increase mill capacity

▶ Driving of the 23,000-ft. Elton tunnel of the National Tunnel & Mines Company at Tooele was resumed on Dec. 1 near the 6,000-ft. mark. Work was suspended last spring when a heavy flow of water developed in the face. This handicap, as well as the fact that bedrock had not been reached, greatly impeded work. During the summer, a number of churn-drill holes were put down. After considerable exploration, the shortest distance to bedrock was mapped. In order to reach the desired solid formation at the earliest moment, drilling of the tunnel was started 400 ft. back of the tunnel face at an angle 30 deg. further south. Bedrock should be entered in a distance of 2,600 ft. Thirty to thirty-five men are employed in the drilling. When completed, the 23,000-ft. tunnel, costing $1,000,000, will provide drainage and cheap transportation for Bingham's deep mines.

▶ The Tintic Standard Mining Company paid a dividend of 10c. a share on Dec. 22, or a total of $115,331. This disbursement made a total of $345,994, or 30c. a share, for the current year and increased the grand total of disbursements to $17,608,104. Tintic Standard recently completed dismantling its old mill at Harold, two miles east of Goshen.

▶ Dr. Eugene Callaghan has completed the geological survey of the Marysvale mining district, which he has carried on for the United States Geological Survey for three seasons. The survey, although it centered its attention on the alunite deposits of the district, also concerned itself with gold, silver, lead, and other deposits. A survey of approximately 400 square miles has been made. He was assisted by Professor Vincent Kelly, of the University of New Mexico.

▶ The Geyser Marion Gold Mining Company, directed by F. B. Bothwell, general manager, is milling about 800 tons of ore daily at its Mercur property. Next spring, Mr. Bothwell announces, the company plans to increase its milling capacity to 1,500 tons daily by installing a primary crusher, which will have a capacity of 150 tons an hour, and two new ball mills. Construction work completed this season added four new concrete thickeners and a precipitation plant to the company's physical assets, Mr. Bothwell reports. In addition, a primary crusher and a ball mill were installed at the Sacramento property. Ore from the Sacramento property is reduced to slime and conveyed by a 5-in. line 3,500-ft. to the mill. Another 5-in. pipe line carries the barren solution up to the Sacramento mine. Two pumps provide power for lifting the solution 350 ft. The solution is circulated 250 g.p.m.

▶ A plant for the concentration of vanadium ore is being erected in Dry Valley, Grand County, according to reports from Moab, where articles of incorporation for the new company were filed, with Bernard B. Kunkle, president; John Hill, vice-president; H. W. Balsley, secretary-treasurer. The company has taken over the carnotite mines formerly owned by the United States Vanadium Corporation and recently acquired by H. W. Balsley, of Moab. It will treat not only its own ores but those of other producers. Capacity of the mill will be 25 tons daily.

▶ The last work is being done in the Utah Copper Company vehicular tunnel at Bingham. About the first of January, it is believed, the tunnel will be opened to the public.

▶ The United States Gypsum Company purchased the Nephi Plaster & Manufacturing Company's plant at Nophi, Utah, on Dec. 20, according to an announcement of Sid H. Eliason, Utah sales representative for the new owners. The Nephi plant will be operated as a unit of the larger company. Approximately thirty men are employed. Sales offices will be in the Dooly Building, Salt Lake City. No announcement was made of the financial consideration given to complete the purchase.

MONTANA

Anaconda Offers Work Plan to Employees

Miners will be assured overtime pay each week according to wage-and-hour law — Gold-bearing limestone replacement orebody at Butte Highland mine being developed in depth

▶ The Anaconda Copper Mining Company announced on Dec. 23 that it is willing to employ men 48 hours per week, paying overtime according to the wage-and-hour law, if employees in Butte, Great Falls, and Anaconda will extend the present wage contract for two years. At present the wage agreement is made on a year-to-year basis ending Sept. 17 each year and becoming automatically renewed at that time unless notice is given by either party not less than 90 days prior to that date in any year that changes are desired in any or all of the provisions of the agreement.

▶ At a recent meeting of the Montana Section of the A.I.M.E., W. L. Bell, manager of the Butte-Highlands mine, outlined the geology and general operating problems noted at its property south of Butte. According to Mr. Bell, the orebody now being worked was not known to exist by previous operators, but was found in driving a 2,600-ft. development tunnel under the generally productive area. The discovery was made approximately 600 ft. below the surface, and subsequent developments have opened two sublevels below that point. To the present greatest depth, the gold-bearing limestone replacement body continues unoxidized, although development has penetrated several hundred feet below the present water table. Operating conditions introducing difficulties have all been overcome, but in accomplishing this a number of unusual practices have been adopted. The orebody is wide and made up of unconsolidated oxide and breccia products which permit it to contain a large volume of water, and at the same time cause the ground to be exceptionally difficult to hold. To overcome the water problem, advance development of levels permitting adequate time for drainage has proved successful. The heavy ground is held by square-set stoping conducted in tier fashion in which sets are filled almost immediately after mining. Offsetting some of these difficulties, the ground may be picked without blasting. Cyanidation is employed in gold recovery at the mill.

▶ According to reports from Mammoth, the Liberty Montana Mines Company, operating there, has experienced a successful year, maintaining steady shipments of concentrates of gold-copper ore to the Washoe Reduction Works. Development on two levels has been continued into the main range of the Tobacco Root Mountains for nearly a mile, demonstrating commercial ore to depths of approximately 2,000 ft. S. Gulio is manager and W. W. Corrigan, of Milwaukee, is president.

BARE FACTS ABOUT BEAR XANTHATES

Question: Say! Every time I open one of my magazines I see your face in it somewhere. What about these Bear Xanthates?

Answer: Bear Xanthates were developed to help solve every flotation problem -

Q - Oh yeah? You'll have to be more specific if you want me to believe that!

A - Well, one of my customers floats 13,000 tons of complex copper-nickel ore per day with Bear Xanthates. Another works native gold with my reagents. And there's one that floats non-metallics - wulfenite and vanadinite - with Bear Xanthates, too.

Q - Not bad. But can't you be even more specific?

A - All right. Here's a list of some minerals Bear Xanthates are floating:

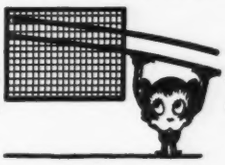
Q - Huh. Quite a list. And how are your Xanthates used on these minerals?

A - Lots of my customers use Bear Xanthates for bulk flotation - on lead, zinc and copper ores. Lots of others save money using my reagents for selective flotation, especially on precious metal ores.

Q - Now, don't get general again. Who are some of these users?

A - There's Alaska Juneau, and International Nickel in Canada, San Francisco Mines of Mexico, and Suyoc Consolidated in the Philippines, Trepca Mines in Yugoslavia, Roan Antelope in Rhodesia --

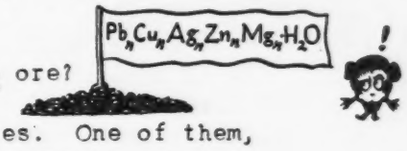
Q - Hey, you're jumping all over the map! I thought Xanthates would deteriorate on long hauls, especially in heat!



A - No sir! Not Bear Xanthates! I can show you 12-month stability records of all my Xanthates. Deterioration in a year's time is only 1.7% to 5.7%!

Q - Is that so? Well, how about actual performance records?

A - Okay. Alaska Juneau's flotation mill makes a profit working 75,000 tons of 30-40¢ per ton ore feed per month. Another mill increased gold recoveries 4% to a total of 98% by using a Bear Xanthate. A Pacific Coast copper property with milling costs of only 30¢ per ton has used 3 of my Xanthates --



Q - You've always got an answer! Now what can you do on this ore?

A - Offhand, I don't know. But that's why I make six Xanthates. One of them, or a combination, certainly ought to do a job even on a hypothetical ore!

Q - All right, all right! Is that all?

A - Yes, except that I'll be glad to send samples for a test run on your ore-

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NEWS FROM Washington

By Special Correspondent

STAMPEDING for the Government pie counter, the mineral industry at the Capital City gives the impression of a gold rush. The "pay dirt" is, of course, the possible chance of getting subsidy or new business from the United States Treasury. It looks as though some folks were going to get trampled during the January and February crush.

Most promising as a benefit for the mineral industry is the proposed legislation to build a stockpile of minerals, as described in *E.&M.J.* last month. (See page 72, December issue.) The urgency of preparedness gives excellent prospect of enactment of this bill, which was formulated in cooperation by five executive departments, War, Navy, State, Commerce, and Interior. Washington notes with satisfaction that mineral folks of long vision have organized in support of the bill through the Mining and Metallurgical Society of America.

Mineral Subsidies

THE CAREER AGENCIES of the Government interested in the mineral industry note again this winter the ever hardy perennial plans for subsidy of tin, silver, manganese, and other commodities of political significance. Newly organized groups are undertaking to get all kinds of aid, varying from direct money subsidy, as for silver, through to subtle types of indirect help under the guise of exploration of limited resources. It is a poor commodity that cannot get itself a preparedness costume in which to parade before the appropriation committees on Capitol Hill.

The price of silver was spotlighted at the year-end by the announcement of the President on Dec. 31 that 64.64c. would continue to be paid for newly mined domestic silver, provided, however, delivery is made to a coinage mint not later than June 30, 1939.

The political influence of silver has been waning. But there is no doubt that the Administration would like to continue to have the support of Western senators who are almost unavoidably spokesmen for silver mining interests of their States. Despite the weird estimates that silver ought to be 24 or 25c. an ounce in the world market, as made by the critics of the silver policy, no one expects so large a drop in price as that. But some downward trend over a considerable period appears an inevitable consequence of waning political influence.

Domestic manganese advocates appear completely repudiated by recent action, including comment of the President. Domestic sources are categorically condemned as altogether inadequate at any reasonable price. The unavailability of alloy grades of manganese ore is noted particularly as an objection to the attempt to build manganese stockpiles from United States mine sources. It looks as though the formerly influential spokesmen of domestic manganese were now practically impotent in their subsidy-seeking efforts.

Perhaps tin, which again seeks a domestic production and a domestic smelting industry, will be most conspicuous in the subsidy limelight during the next few months. There is no doubt that the executive departments would be quite willing to have a domestic tin-smelting industry developed, if it did not cost too much. But the critics of subsidy argue, persuasively, that it is cheaper to buy the tin at the world price and put it into the stockpile than it is to pay the bill of uneconomic mining or over-costly smelting. If Washington can get the hoped-for cooperation of the British and Dutch interests, the tin subsidy plans are likely to go by the board. But forecasting on this subject without knowledge of the current secret negotiations and the active international politics is rather futile.

Strategics Survey

DURING DECEMBER the plan for the advisory committee to assist in mineral preparedness planning was modified and enlarged. The special committee will, it now appears, serve under the auspices of the Army and Navy Munitions Board instead of under the Assistant Secretary of War's office only. Colonel Dwight, who was expected to head the committee, will probably not serve in that capacity; Prof. C. K. Leith, of the University of Wisconsin, is now acting as chairman. With its new sponsorship the committee will influence current purchasing as well as mineral stockpile questions.

It is hoped that a group of subcommittees, one for each of the major strategic minerals, may be organized. The function of each of these will be to gather all the necessary facts and to advise the Government executives of Army and Navy regarding the latest problems incident to maintenance of mineral raw-material supplies during an emergency.

Public Understanding

WHAT appears an organized effort to establish "good feeling between government and business" was an early post-election plan of the New Deal. The job of leading this campaign seems to have been assigned to Assistant Secretary of Commerce Richard C. Patterson, Jr. And that gentleman has been making a number of addresses, most of which center around the monopoly investigation.

Of real significance for the mining industry in appraisal of this Administration policy is one of the texts from which Mr. Patterson "preached" on one occasion in New England. Among other things, he said: "The public must be taken into confidence through the explanation of business policies in terms that everyone can understand."

This concession that business men may be right is important. Even more important is the implication that complete righteousness, or right-ness, must include a public understanding of what is going on in business. Business spokesmen about Washington appear definitely encouraged by this trend of thinking; they hope that it will permeate New Deal philosophy generally.

Dollar Troubles

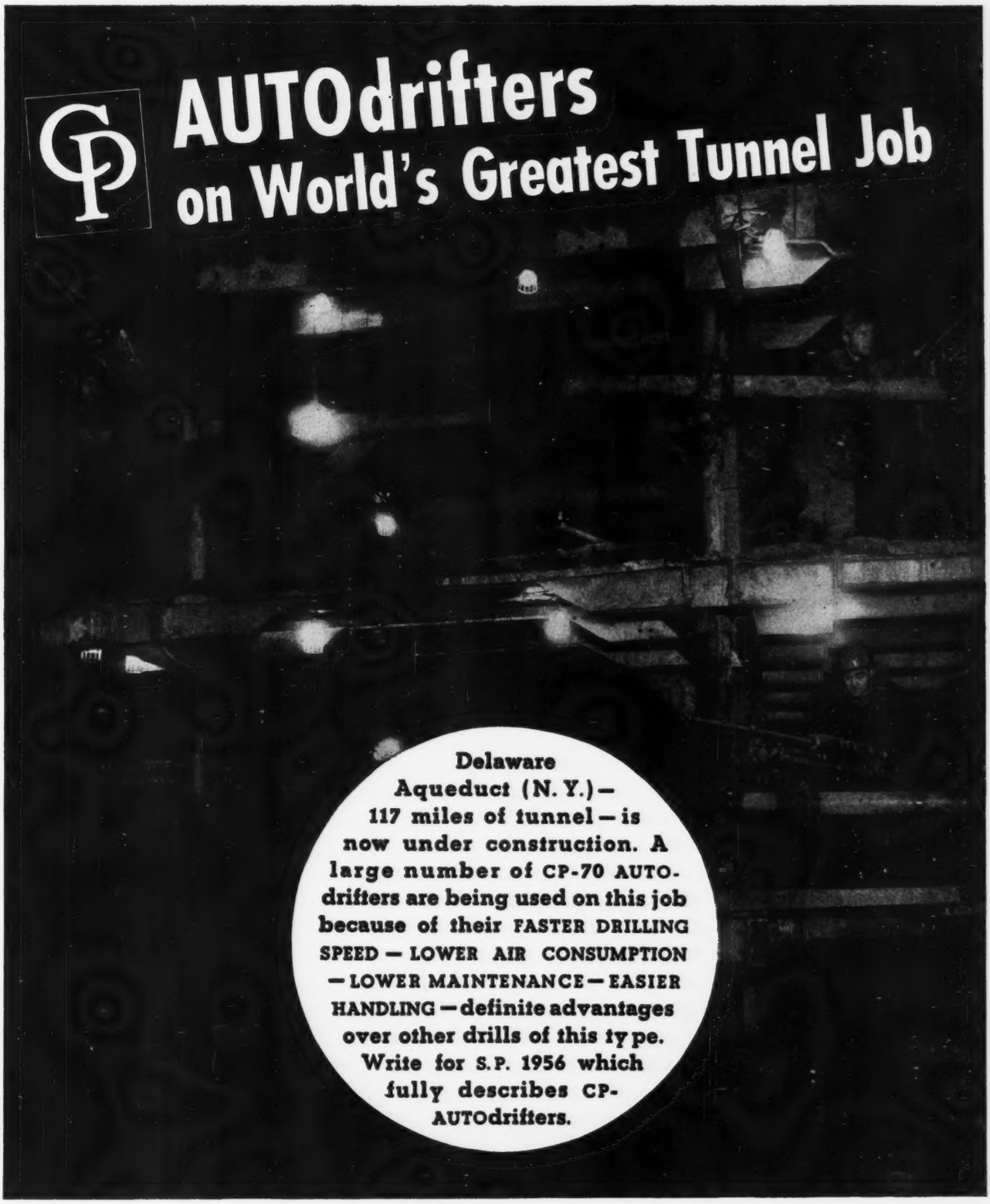
BOTH domestically and in international matters the President is trying to set up a more satisfactory dollar policy. One of the major byproducts of the recent British-Canadian-American tariff agreements is expected to be a new British-French-American fiscal deal. Washington is inclined to think that the United States will offer no objection to further measures which might aid in lowering the gold value of the pound and the franc. Unless those other currencies slip badly, there is no present expectation that new devaluation effort will be made with the dollar.

Wishful thinking has led a few commentators about Washington to suggest that Congress is likely to resume control of these money matters before very long, relieving the President of his responsibility for fixing the gold value of the dollar. Even though the President may not be given as much support by Congress as formerly, he is not likely to have his money management curtailed in this fashion. Even the Republicans in Congress know that there must be some freedom for international trading purposes or the Administration would be altogether ineffective in its negotiations with the other important powers.

Now that the mid-term elections are over there is much less pressure for relief expenditures. Furthermore, much of the needed aid for the unemployed will be given by means of preparedness spending. (This forecast has frequently been made in this column of *E.&M.J.*) This will slightly relieve the pressure on expenditures for relief during 1939, as a general tapering off on relief rolls is expected during the first half of the year. No one really expected an important gesture toward balancing the budget this winter.

A special committee named during November by the President to study fiscal and monetary matters was a sound, intelligent, constructive group. However, the President himself warned the newspaper men, when making the announcement of the appointment, that it might be some time before the committee could be heard from again. Most observers believe that the budget was made up without regard to any findings of that committee. Broad political and social considerations obviously governed, not cold economics or business policy. Despite all of this, Washington, so far, hears very little discussion of "inflation."

The mining industry might as well expect further tax adjustments, mainly upward, as usual. But of the moment, the President has left the means of raising additional revenue up to Congress to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propose ways and means of raising $422,000,000 for increased expenditures for armament and farm parity payments which Congress voted last session. Just what legislative action will be taken in this direction may depend upon the conservative elements now more influential in both houses of Congress.

Profit Sharing

A SERIOUS ATTEMPT is being made to determine how industries may be given some tax encouragement if they are willing to adopt plans for sharing profits with their employees. Also the idea is strongly urged that those enterprises which guarantee practically continuous employment should have some tax reward. Hearings during late November were not very successful in disclosing just how practical such a plan could be made.

Three large corporations known the country over as leaders in profit-sharing arrangements were the first to testify. No one could deny their enthusiastic support for the idea of systems for guaranteeing employment and sharing benefits with the workers. But practical difficulties were clearly revealed by the president of Procter & Gamble, who expressed doubt whether "any human being could pass a law which would get anywhere in enforcing permanent employment or profit sharing."

It is the expectation, as these hearings are in progress, that some form of legislation will be drafted and introduced in Congress during January. But those acquainted with legislative difficulties seem rather inclined to believe that the results will be more educational for industrial executives than effective in establishing new law. As one commentator friendly to the whole idea said, in effect, "Able industrial leadership must lead, not be forced by so-called 'incentive legislation.'"

"Executive" Defined

ALL INDUSTRY WILL WISH to take advantage for administartive, executive, and other management officials of the exemption from the 44-hour limit placed by the Fair Labor Standards Act. Great importance is, therefore, attached to the following portion of an official finding by Administrator Elmer F. Andrews, issued Oct. 19. He defines an employee engaged in bonafide executive or administrative capacity as: ". . . any employee whose primary duty is the management of the establishment, or a customarily recognized department thereof, in which he is employed, and who customarily and regularly directs the work of other employees therein, and who has the authority to hire and fire other employees or whose suggestions and recommendations as to the hiring and firing and as to the advancement and promotion or any other change of status of other employees will be given particular weight, and who customarily and regularly exercises discretionary powers, and who does no substantial amount of work of the same nature as that performed by non-exempt employees of the employer, and who is compensated for his services at not less than $30 (exclusive of board, lodging, or other facilities) for a workweek."

"Buying" Cooperation

FULL EFFECTIVENESS of wage-hour regulations demands the very active cooperation between Federal and State officials. Conferences have been held by Administrator Andrews with the various State labor commissioners, to whom he recently said: "The Wage and Hour Division looks forward to the time when each State will be equipped to take over all investigations and inspections in connection with the administration of the wage-and-hour provisions of the Fair Labor Standards Act."

Assurances have been given in Washington that State groups intend to have a large number of bills before the 44 legislatures which meet this winter. Out of this effort there is likely to come a considerable number of State laws which will be little Fair Labor Standards acts. For the mining industry all this means that even such activities as are intrastate may soon be drawn under wage-hour limits practically the same as those which Administrator Andrews enforces nationally.

In order to encourage this trend, Administrator Andrews hopes to secure authority for the use of Federal funds in State offices from which he will ask direct aid in reporting violations, reporting low-wage-standard industries and establishments, and assisting with propaganda and educational efforts. It is recognized, however, that neither individual field offices of the Labor Department nor the State groups can be safely allowed to make interpretations of the law. All such decisions will, it is expected, have to come from Washington; but application of the law and policing of industries will be as widely distributed as possible.

News "Fines"

Sixteen to One—Those who have been keeping score on the Supreme Court decisions affecting the orders of the National Labor Relations Board say that that agency has won sixteen cases and lost one case. The one loss was in the order against P. & O. Steamship Company, which was instructed by N.L.R.B. to restore the jobs of the men who went out on a sit-down strike. Apparently the sit-down rather than a Board policy was pretty largely the basis of this decision of the Supreme Court, which merely declined to review the Circuit Court action reversing the decision of the N.L.R.B.

Better Business—Government experts are estimating that construction activities will greatly improve business conditions of heavy industries, including mining, during 1939. Renewed activity in house building, ship building, and other preparedness activity is counted on to give renewed buying of mineral and metal products.

Phosphate Reserves—Hearings before the Congressional committee investigating phosphate rock have disclosed that new technology, new explorations, and the possibility of using lower-grade raw material have multiplied several fold the estimates of phosphate-rock reserves in the United States. Even at the peak consumption estimated as at all possible, industry spokesmen now talk in terms of 5,000 years' supply from known sources in the East. The pressure for Western development, therefore, is greatly reduced. This is important to all mining industry because it stakes down one of the sides of the mineral industry tent where the camel's nose of government operation was being poked in dangerously.

Stream Pollution—The new session of Congress will fight over again the battle between complete Federal regulation of stream pollution and the cooperation between State and Federal authorities. The outcome, to be expected in late spring at the earliest, is likely to be a law much like the one which the President vetoed last Summer. This will give the mining industry plenty to think about, but assures a reasonable period for development of pollution-prevention methods where the enactment of special legislation seems to be required.

Labor Is "Interstate"—The National Labor Relations Board was somewhat limited in the application of its orders to the Consolidated Edison Company as a public utility doing business almost exclusively in New York State. But the Supreme Court in this finding did say definitely that even the generation of power for local use was so important as affecting interstate business of the railroads and customers as to give the Federal authorities many rights of supervision in the application of Federal law. This would seem to mean that most labor questions of mining are bound to be interpreted as interstate in significance, if they should reach the Supreme Court.

Cabinet Changes—Misunderstanding of the Congressional approval of certain Cabinet changes which the President wishes to make has been quite general during December. Senators are generally rather willing to let any President select his own immediate advisers for the Cabinet, even when the majority of the Senate does not like the mer individually or their policies. Confirmation of such persons as Harry Hopkins should not be taken to imply approval of that gentleman, for he certainly would not be confirmed by the Senate if proposed for a judicial or quasi-judicial commissionership. This means that only the President is thought to be entitled to have about him his preferred advisers, even when these men are not really considered acceptable to the confirming body for non-political posts.

T.V.A. Competition—A large quantity of concentrated fertilizer material made by T.V.A. is being marketed through the Department of Agriculture A.A.A. soil-improvement program. Miners of phosphate rock complain about this. The Department officials merely answer that they would buy this same kind of concentrated fertilizer commercially, instead of from T.V.A., if they could get it. The long-run effect may be education of the farmers in using more economic types of material, but meantime the pressure of real competition upon private industry by T.V.A. *is* significant.

Angles of the Wage-and-Hour Law in the Non-ferrous Metal-mining Industry

OF PARTICULAR INTEREST to the mining industry is an interpretation recently issued by the Wage-Hour Administration. The question, concerning hours of work for smeltery workers and continuous operation plants, was one of some 25 submitted by the American Mining Congress to the Wage-Hour Division for answer and elaboration for industry members by Wesley O. Ash, regional director, who was a speaker at the annual metal mining convention recently held in Los Angeles. Because of the importance of the interpretation, the official explanation of the agency is carried in full:

A smelting and refining company, with offices in New York City, sought information about determining workweeks. The General Counsel's office replied as follows:

You ask whether upon the following state of facts an employee A will have worked more than 44 hours during any workweek:

"The workweek of employee A is fixed so as to commence at 12 o'clock noon on Saturday and end at the same time the following Saturday. A's working hours are from 8 a.m. to 4 p.m. He works on Monday, Tuesday, Wednesday, Thursday, Friday, and Saturday morning of one workweek and Saturday afternoon, Sunday, Monday, Tuesday, Wednesday, and Thursday of the following workweek. He then lays off Friday, Saturday, and Sunday and resumes the schedule on the following Monday. Thus he works 11 consecutive days of 8 hours each, followed by a three day lay-off. This schedule is continued indefinitely."

It is our opinion that there is no objection to A's workweek beginning at the middle of his shift on Saturday. As you point out, our Interpretative Bulletin No. 4 provides that the workweek "may begin at any time of any day." It would not be possible, however, to make a change in the hour at which the workweek was to begin, except where that change was intended to be permanent. You realize that this is an informal expression of opinion for your benefit and would not be binding upon the courts.

CALIFORNIA — Most operators have changed working hours to comply more or less with the wage-and-hour law, but the consensus of opinion appears to be that in view of the recent decision of the United States Circuit Court of Appeals for the Ninth Circuit in the case of N.L.R.B. vs. Idaho Maryland Mines Corporation the new law does not apply to most of the California gold mines. The court in its decision stated that all gold-mining operations where bullion is shipped to the mint at San Francisco, and where materials and supplies are, with minor exceptions, purchased within the State, operations are intra-state under the Wagner Act, and many believe operations obviously would also be intra-state under the Fair Labor Standards Act. Many believe that the purpose of the law is constructive, but in case of gold-mining operations some are so marginal in character that any additional expense would be a severe burden and would be justifiable in non-compliance voluntarily, where the question of interstate commerce does not enter.

At one property where operating conditions are very favorable and the mine has no extensive workings, either laterally or at depth, the management expects costs of operations will advance 7 per cent of its present figure. At the mill two extra employees are required, but underground they would accomplish in seven hours what is now done in eight hours. Some labor saving devices, however, would be necessary and purchases of additional equipment will probably have to be made.

MONTANA—In general the reaction to the wage-and-hour laws is unfavorable both to employer and employee, the former objecting to added non-productive expense and the latter to what constitutes a cut in income. In many smaller camps, idle time is of little benefit to a worker, who would prefer to work full time. In one camp staggering of shifts has eliminated any semblance of a regular workweek for the individual, as the day his week begins differs each week. In most of the small camps employment to date has not increased because of the act. In the Butte district, where standardization and simplification of accounting and superintendence are vital, the intermediate adjustment to a 44-hour week has been virtually insolvable, and the change has been directly to a 40-hour, five-day week, with a slight increase in employment, but the income per employee has been reduced. One gold property in an isolated section has worked for years on a seven-day basis and with full cooperation of the employees. They elected to continue on that basis, but fearing possible challenge on the intra-state interpretation, time and a half is paid for the service above 44 hours. This course was deemed justifiable from the management's point of view because of the mines' isolated location. Another property working only about 60 men on two shifts, but handling 80 per cent of the ore at night owing to a very unusually complex sampling control, has been unable to establish any workable schedule of a systematic nature. Consequently, the added cost of bookkeeping and supervision is increased. It appears that small operators will suffer most and that the increase in employee rolls that might be credited to the plan will be offset by actual shutdowns of marginal operations owing to added expense. In larger operations, the attempt will be to increase mechanization wherever possible, but in these units also, costs are usually in delicate balance, and with everything working towards their increase, unless metal prices are raised, observers have reason to doubt that employment in mines will be increased.

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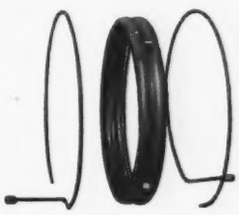

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ARIZONA

Small Mine Operators Maintain Steady Output

Numerous scattered mines in many districts supply smelters with fluxing ores and concentrates—Gold Standard Mines, Inc., will rehabilitate Tyro mine, in Mohave County

▶ From two to three carloads of gold ore per month are being shipped from the Gold Queen property, in the Dripping Springs country 25 miles south of Globe. The property is operated by Dick and Steve Cocheran, of Globe.

▶ C. H. Brooks, representing British capital, has taken over the Apache Vanadium Corporation. The properties are in the Radium district.

▶ The old Jonah group, in the Silver Reef Mountains, is being operated by the owner, R. W. Wood, of Casa Grande. Carload shipments of gold ore are being made.

▶ H. S. Freeman, of Tucson, and C. A. Patterson, of Casa Grande, owners of the Mammon mine, are making shipments to the McNatt mill at the Turning Point mine.

▶ The Jack Rabbit Extension property, near Casa Grande, is being developed by George W. Long, of Phoenix. Several men are employed.

▶ Dan Main and Howard Nottier are shipping 50 tons per day from the Bluebird mine, on Cave Creek. The sulphide ore contains gold and copper and is shipped to the International smelter at Miami.

▶ O. L. Pearson and L. C. Smith are working the Little Joe mine under lease and shipping gold ore. The property is in the Tip Top district north of Phoenix.

▶ The Maricopa mine, 5 miles north of Cave Creek, has been shipping a carload of gold ore per week to the Magma smelter at Superior. It is now remodeling the mill on the property.

▶ J. W. Daily, 309 Valley National Building, Tucson, president of the Daily Mines Company, plans to start production in January. The gold-silver-copper property is in the Old Hat district.

▶ Golden Desert Mining Company is operating the Flower mine, on lower Humbug Creek 2 miles above the Agua Fria River. The property is equipped with a hydraulic giant, a shovel, a bulldozer, and riffles. The company is headed by R. King, of San Jose, Calif.

▶ A tunnel is being driven on bench gravel for placer work at the Bokares mine, 4 miles above Clifton on the San Francisco River. This property has been a small producer for many years.

▶ Larry Burton has taken over the Richardson property, a half mile from the Little Daisy mine, in the Sunflower district northeast of Mesa. Extensive development work is planned. Burton is operating the Little Daisy under the name of the Golden Rule Mining & Milling Company. A 25-ton mill is installed on the property and is reported making an excellent recovery. E. H. Lundquist is consulting engineer.

▶ Dean M. Hogue, of Kingman, is operating a property in the Music Mountain district of Mohave County. The ore is being shipped to the Vivian mill, at Oatman, for treatment. The Music Mountain district has been inactive for many years.

▶ Four men are employed at the Continental mine, near Globe, which is being developed by H. Steadman Williams and E. E. Hale, of Globe. Two trucks are used in hauling the gold-silver-copper ore, and it is planned to begin shipments of three carloads per week to the International smelter at Miami.

▶ Mrs. Rhoda Noblechek, of Wendon, owner and operator of the Critic mine, in Cunningham Pass, is mining gold-copper ore on the 200 level and is making regular shipments to the Hayden smelter. Some of the ore is said to average from one to two ounces in gold.

▶ Gold Standard Mines, Inc., operating their mill at Katherine, in Mohave County, have recently taken over the Tyro mine, some 5 miles distant. They have installed a compressor and other equipment and ore will be hauled to their mill. Richard de Smet is general manager.

▶ A carload of ore per month is being shipped from the Queen Creek Copper Company's property near Superior. The mine is operated by Richard Manner and F. Harrington under lease.

▶ Herron and Laster, Inc., have the Lake Superior and Arizona properties, near Superior, under lease. A crew of eighteen men are employed and 800 tons per month are going out for treatment. Con Laster is in charge of operations.

▶ A carload of silver ore per day is being shipped from the Reymert mine, near Superior. The property is under lease to W. J. Forbach, of Superior.

▶ Malco Mining Company is operating a 35-ton flotation plant on the O. K. mines, in Gold Basin 50 miles north of Kingman. The company expects to increase the capacity of the plant at an early date. Dan Harper is superintendent. Ernest Malouf, 155 West Washington Boulevard, Los Angeles, Calif., is president of the company. The ore contains gold, silver, and lead. A Marcy ball mill and a Denver flotation unit are used in the mill.

▶ The Ray branch of the Nevada Consolidated Copper Corporation, at Ray, Ariz., is now employing 600 men and shipping two trains of crushed ore daily to the Hayden mill. Thirty-eight 60-ton cars are transported in each train, and the daily production delivered is approximately 6,000 tons. Robert W. Thomas is general manager.

▶ Negotiations are under way with dredging interests for the extensive development of the Middlecamp Placers, near Quartzsite, owned by W. G. Keiser, of Quartzsite.

▶ Producers Mines, Inc., since the installation of their new cyanide plant, are receiving ores from the Klondike and Scout properties, which they control, as well as from the Pilgrim property, near the mill. Recently the company took over the Juno property, north of Chloride, and is hauling ore from that property to its mill.

▶ Chloride Reduction Company is steadily treating ores from the Rainbow property, owned by the Grand View Mining Company. These two companies are operated by the same management.

▶ Tom Atkinson, owner of the Pump mine, near Aguila, is operating a ten-stamp mill and treating the gold ore from the mine.

▼

Chronology of New Deal Silver Legislation

• 1933 •

May 12, 1933 . . . Congress passes Thomas amendment to farm relief bill (1) authorizing the President by proclamation to fix the weight of the silver dollar at a definite fixed ratio to the gold dollar; (2) providing for unlimited coinage of gold and silver at the fixed ratio, (3) authorizing the President to accept silver at a price not in excess of 50¢. per ounce in payment of debts for foreign governments to the United States.

July 22, 1933 . . . Eight governments in the World Economic Conference, London, agree, subject to ratification, to restrict sale of silver and increase monetary uses for four years beginning Jan. 1, 1934. India, Spain and China undertake to sell silver; Australia, Canada, United States, Mexico, and Peru to buy.

Dec. 21, 1933 . . . International agreement ratified by executive order of President Roosevelt. Provides for Treasury purchase of about 25,000,000 oz. per year for four years. Proclamation sets the price of newly mined domestic silver at 64½¢. per ounce.

• 1934 •

Jan. 30, 1934 . . . Monetary bill approved with Pittman amendment for expanding use of silver in currency.

June 19, 1934 . . . President signs Silver Purchase Act providing for purchase of silver by the Treasury up to one-fourth of the value of total monetary metal stocks.

June 28, 1934 . . . Treasury places embargo on silver exports except under license.

August 9, 1934 . . . Nationalization of silver by presidential proclamation at 50.01¢. per ounce, to effectuate policy of Silver Purchase Act.

• 1935 •

April 10, 1935 . . . Price of newly mined domestic silver set at 71.11¢. per ounce by presidential proclamation.

April 24, 1935 . . . Price of newly mined domestic silver set at 77.57¢. per ounce by presidential proclamation.

• 1937 •

Dec. 31, 1937 . . . Price of newly

mined domestic silver set at 64.64¢. per ounce by presidential proclamation. Expired Dec. 31, 1938.

• 1938 •

Dec. 31, 1938 . . . Price of newly mined domestic silver set at 64.64c. per ounce for silver to be delivered to a United States coinage mint not later than June 30, 1939.

The proclamation by the President follows:

"I, Franklin D. Roosevelt, President of the United States of America, do hereby further modify the said Proclamation of the twenty-first day of December, 1933, so that the same shall remain in force and effect until the 30th day of June, 1939; and I do proclaim and direct that, unless repealed or further modified by Act of Congress or by subsequent Proclamation, the said Proclamation of the twenty-first day of December, 1933, as heretofore and hereby modified, shall remain in force and effect until the 30th day of June, 1939; *provided, however,* that silver to be eligible for receipt under said Proclamation of twenty-first day of December, 1933, as heretofore and hereby modified, must be delivered to a United States coinage mint not later than June 30, 1939.

"Notice is hereby given that I reserve the right by virtue of the authority vested in me to revoke or modify this Proclamation as the interests of the United States may seem to require.

"In witness whereof, I have hereunto set my hand and caused the seal of the United States to be affixed."

IDAHO

Star Mill of Hecla Mining Enlarged

Plant gradually stepped up from 750 to 900 tons' capacity—Agreement made for development of Silver Syndicate from deep levels of Sunshine Mine

▶ The star mill of the Hecla Mining Company, at Burke, in the Coeur d'Alenes, has been modernized and enlarged to a capacity of 900 tons daily. It was recently tested in trial runs. The mill is one of the most modern in the West and will operate on a flotation principle exclusively. It is equipped to make double separation and fine grinding of lead and zinc concentrates, and fine grinding of all ores will be possible.

▶ Bunker Hill & Sullivan Mining & Concentrating Company reports profits after capital expenditures, but before depreciation, depletion, and income taxes, of $142,744 for October, compared with $186,427 in September and $262,471 in October of 1937. For the first ten months of 1938 the profit on the same basis totaled $818,302, compared with $2,867,601 for the like period of 1937.

▶ Walter G. Palmer, Jr., of Wallace, has announced on behalf of Silver Syndicate, Inc., of which he is president, that he had signed the agreement which provides for the development at depth of Silver Syndicate from Sunshine's deeper levels. Negotiations between the two companies have been under way for some time and the consummation of the agreement is one of the most important transactions in the silver belt since Hecla and Newmont started deeper development in the Polaris. A feature of the agreement is that it provides that any ore encountered in this crosscut before it reaches Silver Syndicate ground may, at Sunshine's discretion, be mined and milled by it without the necessity of first determining ownership. If doubt as to ownership exists, the proceeds, after deduction of expenses, will be impounded until ownership of the vein is determined. This is imporant in that any apex litigation should be avoided.

▶ Operations at the Gibbonsville property, near Gibbonsville, are now proceeding on a three-shift basis. The mill is being stepped up to its capacity of 200 tons daily.

▶ Sunshine Mining Company has paid the fourth quarterly dividend, at the rate of 40c. per share on the issued capital stock of 1,488,821 shares. The total disbursement, paid on Dec. 24, was $595,528.40. The mine and mill employ approximately 600 men throughout the year, now working on a 44-hour week basis in conformity with the new Federal wage-hour bill. According to the report of Manager R. D. Leisk, the mill is now handling 918 tons of ore daily.

▶ One of the major mining operations in southern Idaho is under way at the

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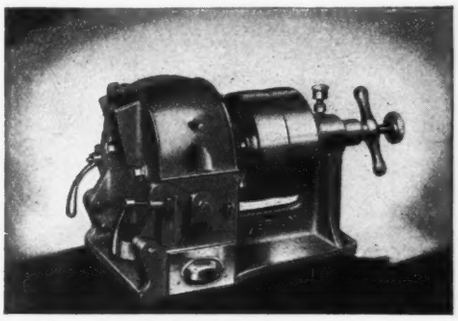

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▶IDAHO

Triumph mine, in Blaine County, controlled by the Snyder Mines, Inc. Recent ore developments are said to have placed the lead, zinc, and silver mine in a favorable position, with production now up to capacity. The mine will employ about 300 men during the winter, it is stated. Output has been augmented by operations between the Triumph and the adjacent North Star mine, total output being about 150 tons per day.

▶ Good progress is reported at the Callahan Consolidated property, in the Nine Mile district of the Coeur d'Alenes, where a search is under way to explore the ore resources of the Rex and Okanogan veins at considerable depth. The Rex vein, on which a drift is now progressing, is a strong fissure which yielded a large tonnage from above the 700 level a number of years ago. Present workings are 200 ft. deeper. The drift will reach a point beneath an ore showing on the upper levels within about 100 ft. from the present face, it is reported by the management.

▶ The famous old-time Livingstone mine, in Custer County, is again operating, with a crew of fifteen men engaged in diamond drilling in a search for new orebodies. The mine was acquired about a year ago by New York and Portland interests headed by G. Spencer Hinsdale, of Portland, from Lewis Twyman, of Miami, Fla., the principal owner, according to reports from Boise. The new owners plan to prospect about 3,000 ft. with diamond drills.

COLORADO

Good Strike Made at Midnight Mine

High grade silver-lead ore found in a winze at property near Aspen—Freight and treatment charges lowered on ores sent to Golden Cycle mill—Vanadium Corporation builds mill to treat tungsten ores

▶ The silver-lead strike of the Midnight Mining Company in the Roaring Fork district, 4 miles from Aspen, Colo., has created much interest in that section. The ore, found in a winze, contains around 900 oz. silver and nearly 50 per cent lead. This property comprises 35 patented claims, and is operated by F. D. Willoughby, president and general manager. The property has a 50-ton concentrating plant and the mine is developed by shafts connected to a 6,700-ft. adit and by raises.

▶ The Metals Recovery Company, operator of the Hunter Creek mill, will concentrate ores from the old Johnson dump, on Smuggler Mountain, according to Manager Frank J. Kealy.

▶ The Golden Cycle Corporation, at Colorado Springs, recently announced a reduction in freight and treatment charges on ores from the district up to $22 per ton. After Dec. 1, the company will pay $32.76 an ounce for gold up to five ounces, and above that will pay the increases that have been in affect for several years. Up to $5 a ton the shipper will receive 60c. more than at present, and 73c. per ton for ores ranging from $8 to $10 per ton; this is the greatest class benefit. These reductions in charges were brought about by A. H. Bebee, superintendent of the mining properties; E. W. Winslow, of the Midland railroad, and Max Bowen, general manager of the mill at Colorado Springs.

▶ In the Georgetown section, mining activity continues as in the summer, due to the fine operating winter conditions. Pay ore is being taken again from the Red Elephant mine, at Lawson. The Mint mine, in North Empire, is resuming operations under Henry Nelso and the Coffman brothers. The Viking Gold Corporation is leasing blocks of ground in the Conqueror. The Stella-Independence group, at Dumont, controlled by Dr. Mentor, is being rehabilitated, Lucky Metals Company, of Idaho Springs, is arranging to install power equipment and plans to enter production soon. The long litigation over the Little Mattie mine has ended, and the mine will reopen in the spring. The new owners, The Federated Metals of Colorado, Inc., have assumed all indebtedness.

▶ Golden Cycle Corporation will construct an $18,000 steel ore house with complete washing equipment at its Ajax property on Battle Mountain. Mr. Bebee, superintendent of the Carlton interests, states that the new washer will handle the daily production and the reject ore dumps as well. It was recently reported that new ore has been discovered on the company's Bobtail vein at the 23d level; and that development of the find is under way.

▶ The Timberline Dredging Company is now operating on Beaver Creek, after spending $100,000 in testing the gravel. The dredge will handle 3,500 to 5,000 cu. yd. per day.

▶ Veta Mines, Inc., at Telluride, has installed two new centrifugal pumps and mucking machines are now being used on the 16th level. Robert H. Sayre, of Denver, Colo., is president; John Ferguson is mill superintendent, and Charles Glasgow, general superintendent at Telluride.

▶ John V. Harvey, president of the East Argentine Mining & Milling Company, in the Cripple Creek district, plans additional financing to continue development work. Part of the property is now being worked by leasers, obtaining good returns.

▶ Tungsten mines in the Boulder district are active. The Vanadium Corporation of America has nearly completed its new 30-ton mill at the Old Conger mine for concentration of tungsten ores. The Conger mine has three veins, the Middle, East and Conger, two of which united on the strike on the 450-ft. level and produced an excellent orebody.

▶ Interest has been displayed in certain mining sections in the new tungsten car-

bide rotary drill for drilling operations, the important question being the supply of power, which has been solved by the Kohler automatic power and light plants. These plants are small, compact, and can be easily carried over the mountains to isolated mining camps.

▶ John Bowman, president of the Cashin Montrose Mining Company, has secured a bond and lease to operate the Cashin property, consisting of 150 acres, in Montrose County. A 50-ton concentrating plant will be built to treat ore containing gold, silver, and copper.

▶ The Jennie Parker mine, just south of Silverton, has resumed operations. H. G. Burgess has leased the property from the Mystery Gold Mining Company. Mr. Burgess is also superintendent of the Champion mine, in Animas Canyon.

▶ H. J. Johnson, manager of the American Smelting & Refining Company, says that the company has driven the tunnel over 900 ft. at the Fairview. Due to a fault encountered, the Florence vein was not cut at the point expected, and the tunnel has been advanced another hundred feet. After the Florence vein is cut, development work will continue along this vein until the Silver Chief is cut.

▶ The Sweeney Construction Company of Denver is making good progress in the construction of the Rico-Argentine mill.

▶ Many properties are producing near Telluride. Most of the operations are in the Ophir-Telluride district. C. L. Brown is working at the top of Ophir Pass. D. Harrison and Tom Mahoney recently made a shipment of ore to the smelter. The Smuggler Union, Butterfly, Alta, Tomboy, and Carbonero are the larger operations, maintaining steady development and production. J. M. Belisle & Sons are working the Hattie, near Ophir loop, and the Unaweep Mining Company is working near Sawpit. George B. Young is producing gold ore from the Special Session, in the Mount Wilson district.

Rand Mining Students Touring United States and Canada

▶ Thirty students of mining in the University of the Witwatersrand, Johannesburg, S. A., under the direction of Prof. C. W. B. Jeppe, dean of engineering, arrived in New York on Dec. 24 for a six weeks' visit to the mining, industrial, and educational centers of the United States and Canada. The party will sail home from New York on Feb. 16.

Among the mining centers to be visited are Timmins and Sudbury, Ontario, Canada; Hibbing, Minn.; Lead, S. D.; Butte, Mont.; Wallace, Idaho; Tintic, Bingham, and Garfield, Utah; and Climax and Colorado Springs, Colo.

Schools of Mines will be visited in Minnesota, Montana, California, and Colorado. Ingersoll-Rand's factory at Phillipsburg, Pa., and the Ford Motor Company's plant in Michigan are also on the itinerary, as are Hollywood, Calif., and the Grand Coulee dam, in Washington.

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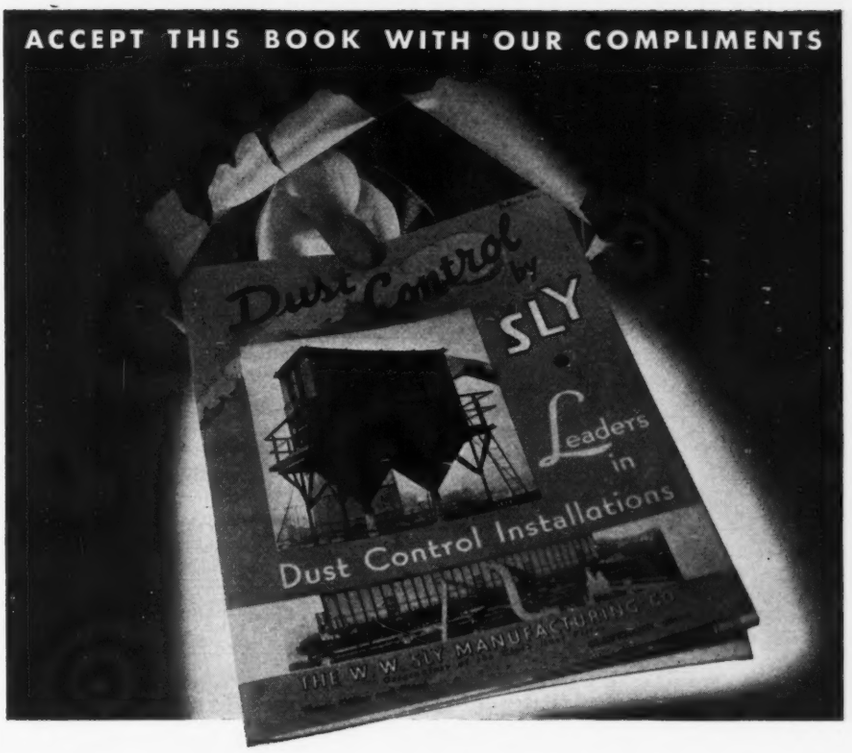

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TRI-STATE

Several Properties Shut Down Operations

Lower prices for concentrates, influenced by lower zinc tariff in recent trade agreement, begin to affect district, throwing men out of work—Eagle-Picher Mining & Smelting buys properties of Commerce Mining & Royalty Company

▶ With the price of zinc concentrates down to $29 per ton, the local industry is faced with a difficult decision. Most companies have continued operations in the hope that the London market will pick up sufficiently to permit the price in this country to advance to a profitable level. Most tailings re-treatment operations are unprofitable at present concentrate prices, and it is generally expected that if a severe cold spell stops operations many will not start up again. Shipments of concentrates have remained fairly steady, as the smelters had sold considerable metal for first-quarter delivery before the tariff reduction was announced. After these requirements have been filled the future is problematical.

▶ The United Lead & Zinc Company and the Burton Mining Company closed their properties early in December. Federal Mining & Smelting Company closed its Jarrett mine and mill about the middle of the month. The American Zinc, Lead & Smelting Company closed its Robinson mine and mill about the same time. The latter two properties have tapered off operations from five 16-hour days to part-time 8-hour operations before closing entirely. Approximately 100 men have lost their jobs by the shutdown of these properties.

▶ Sale of the mining properties of the Commerce Mining & Royalty Company to the Eagle-Picher Mining & Smelting Company was announced Dec. 29. The transaction was the largest in the history of the district. Terms of the settlement were not disclosed. Properties of the Commerce Company included all mines, mills, mining leases and fees, mining and milling equipment and machinery, the company's large power plant, and the mine supply and warehouse. The power plant, which supplies power for all the C.M.&R. Co. mines, was built at a cost of more than $1,000,000 and has a capacity of 10,000 hp. The Bird Dog central mill, with a capacity of 110 tons per hour, is the second largest in the field. The deal was considered by informed persons as making the Eagle-Picher one of the largest producers of zinc concentrates in the United States.

Officials of the company announced no immediate changes would be made in the management or operating arrangements of the newly acquired properties. Principal owners of the Commerce company, a business trust, are George L. Coleman, Sr., George Coleman, Jr., C. M. Harvey, Jr., John A. Robinson, Mrs. James F. Robinson, Mrs. Roy T. Wills, Mrs. Claire Youse, and C. M. Harvey, Sr. Officers of the company are George L. Coleman, Sr., president; C. M. Harvey, Sr., vice-president and general manager; C. M. Harvey, Jr., secretary-treasurer; A. Scott Thompson, general counsel; R. J. Tuthill, auditor; and B. A. White, cashier. The Commerce company began operations in the Oklahoma field in 1907. It was the largest independent operator in the district for many years. Operating mills at present include the Bird Dog, Blue Goose, SeeSah, Webber, Wilbur and the Beaver tailings re-treatment mill, one of the largest in the district. The company held several thousand acres of mining leases, a large part of which was on Indian land in Oklahoma, and several hundred acres of land in fee. Its holdings include the largest known commercial ore reserves in the Tri-State district.

▶ For the Tri-State district as a whole, the year just ended fell below 1936 and 1937 statistically. It did, however, surpass 1935.

MICHIGAN

Copper Range Buys Lake Copper Company

Holdings include 790 acres of mineral rights in Ontonagon County—Calumet & Hecla gives bonus to employees—Isle Royale Copper recovering silver from copper ore

▶ All property rights, franchises, and assets of the Lake Copper Company, real and personal, except cash and securitjes in banks, were purchased recently by the Copper Range Company at a public auction held at the court house in Ontonagon County, pursuant to a dissolution agreement voted by the stockholders and directors of the Lake Copper Company. Receipts from the sale, together with cash assets and securities, will be distributed among the stockholders of the Lake Copper Company in accordance with the dissolution agreement. The properties purchased by the Copper Range Company include 1,317 acres of land, 790 acres of mineral rights, and the Lake Copper Company's plant and seven dwellings at the Lake mine location, Ontonagon County.

▶ Each of the 1,800 employees of the Calumet & Hecla Consolidated Copper Company received a bonus of $12.50 on Dec. 15 and the stockholders a dividend of 25c. a share Dec. 16. The bonus totaled $22,500. Shareholders in the Michigan district received $87,500.

▶ Isle Royale Copper Company, which has been producing over a half million pounds of refined copper per month for the last two months, is now near the 600,000-lb. mark. Yield is 25 lb. of copper per ton of rock treated—the highest yield in the mine's history. At the Quincy mine, production is at the rate of 750,000 lb. of refined copper per month. Considerable silver is being recovered from copper rock mined in the north end of the property, where values are good. A total of 480 men are employed.

IRON COUNTRY

Operators Confine Work To Stripping and Repairs

Oliver Iron Mining Company increased work week during December—Better season during 1939 is expected by the industry

▶ The consumption of Lake Superior Iron Ore by blast furnaces during November amounted to 3,150,073 tons. This was an increase of 369,488 tons over the figures for the previous month and a gain of 415,569 tons over the like period of a year ago.

▶ Furnaces in operation on Nov. 30 totalled 95 out of an available 188, compared with 88 the month before. Shipments during November from the Lake Superior district amounted to 1,481,305 tons. This would leave a balance on hand Dec. 1 of 36,924,801 tons. If the steel operations continue as expected, the consumption of iron ore should run over 3,000,000 tons a month and on May 1 a normal balance of 20,000,000 tons should be realized. If business continues at this rate, the Lake Superior district could expect at least a 40,000,000 ton operation during the 1939 season.

▶ Practically all major operators are doing either stripping or considerable repair work at the various mines and shops. The Oliver Iron Mining Company is now employing men four days per week, compared with three days a month or two ago. After Jan. 1, however, operations will be curtailed slightly.

CANADA

Stadacona Rouyn Mine Plans Expansion

Shaft will be sunk to 1,600 ft. and six new levels opened—Malartic Goldfields completes drilling program—Output increased at Big Missouri

▶ Gold output in Canada for the first ten months of 1938 was 3,871,956 oz., a new high record. For the same period last year production was 3,380,735 oz., and in 1936 3,095,435 oz.

Quebec

▶ Stadacona Rouyn Mines, with production valued at $733,610 for the first eleven months of 1938, has more than doubled output of the previous year. Ore reserves are improving steadily, and a program of major mine expansion is to be carried out in 1939. The main shaft, now down to 975 ft., is being deepened to 1,600 ft. and a block of six new levels opened up below the 850. The ore occurrence is in lenses irregularly distributed along a wide shear zone associated with the Pelletier Lake

fault, making it possible to break the ore in large stopes. A wide calcite vein was discovered in October, heavily impregnated with native gold. This spectacular showing has been followed by a raise from the 725 to the 600 level, the ore helping to establish a new high production record in November. Murray D. Kennedy is mine manager.

▶ Malartic Goldfields, located in the east section of the rapidly growing Malartic camp, has just completed a drilling campaign that indicates one of the outstanding orebodies to be turned up in 1938. The ore zone has been tested for a length of 1,300 ft., and both ends are still open. Core intersections at 100-ft. intervals between 150 and 200 ft. depth show true widths of 12 and 15 ft. for two of the three veins, with average gold values of $9 a ton. The third vein is not so wide and is lower in grade. Shaft sinking has been started on the north zone. Dr. R. A. Halet is resident manager and J. E. Norrie consulting engineer.

▶ John Knox, Jr., manager of Francoeur Gold Mines, reports millheads averaging $7 per ton in the new plant that went into operation two months ago. Flotation concentrates are being shipped to Noranda, where smelter charges are 69c. a ton. Monthly profits are running better than $5,000. A large orebody located by drilling some distance to the west will be explored later by a long drift on the fourth level.

▶ Amm Gold Mines is scheduled as the next producer in the Cadillac district. Negotiations are in progress for a mill rating 100 to 150 tons' capacity. The mine manager, George E. Smith, estimates 104,400 tons of ore indicated to a depth of 500 ft. The No. 4 orebody shows an average width of 3.5 ft. and the No. 2A body averages 9 ft. Both ore zones show an irregular distribution of gold that made it necessary to carry on sampling by means of a 2-ton test mill. The type of mill to be installed will probably be straight cyanidation, which has been found to recover better than 98 per cent of the values, after coarse gold is removed by a jig. The four levels of the mine have been developed by a total of 4,300 ft. in drifts and crosscuts.

Ontario

▶ A month before the new transmission line from Red Lake to Uchi Gold Mines was scheduled to carry power, the Hydro-Electric Commission announced plans for extending the line another 112 miles eastward to make 4,000 hp. available for the Central Patricia and Pickle Crow mines. Opening the right-of-way has already been started, with the objective of turning on the current next August. Jack Hammell, who was active in negotiations for the power line, is advocating a winter road over the same route, to connect with the railway at Savant Lake. Pickle Crow Gold Mines has a large program of mine expansion in the blueprint stage to take advantage of the new power supply.

▶ Development work at Hard Rock Gold Mines has been concentrated for several months on the massive ore along the north zone, and it is now in condition

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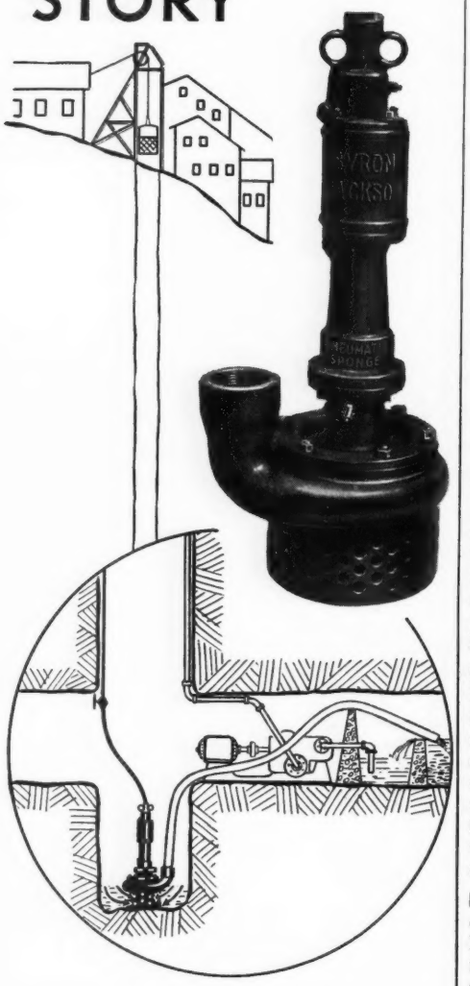

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▶CANADA

to supply total mill feed. At the first of January mill capacity is being stepped up to 300 tons daily. As soon as a roaster is installed a higher recovery is expected from the arsenical ore. A test plant to treat 8 tons of arsenopyrite concentrates is now being erected.

British Columbia

▶ The Polaris-Taku mine, the most northerly lode producer in the Province, has now been in production for about a year, and development in this period has indicated a prolonged and important operation. The mill is currently treating about 6,000 tons of ore a month, the grade averaging ½ oz. gold per ton. The largest vein has been opened for a length of 1,000 ft., and contains an oreshoot 800 ft. in length and 10 ft. wide on the average. Development was made difficult by the mine's inaccessibility, 50 miles from the sea in mountainous country, and the complexity of the geology and metallurgy. These obstacles have been overcome by persistent and methodical study, and operating costs have been greatly reduced. B. B. Nieding is superintendent and D. C. Sharpstone is consulting engineer. The enterprise has been financed by the Edward C. Congdon interests, of Duluth, Minn.

▶ Good results are being obtained at the Bralorne mine, Bridge River, in opening the extensive vein system at greater depth. The total length of the veins opened at the 10th level was 5,000 ft., and to date about 2,000 ft. have been developed at the 14th level, 600 ft. below the 10th. The grade and width of the ore have been maintained. R. Bosustow is managing director.

▶ The Privateer mine, at Zeballos, produced gold to the value of $117,912 in November, from 2,289 tons milled, which included some waste. Recovery per ton averaged 1.456 oz. gold. It is reported unofficially that the Goldfield mine, adjacent to Privateer, has been sold by Spud Valley Gold Mines to a Seattle syndicate for $750,000. The 50-ton mill at this property was set in operation in November. Steady progress is being made in the development of other mines in the Zeballos district on the west coast of Vancouver Island.

▶ Some 100 miles south of Zeballos, in the Alberni area, the Havilah mine is being operated by the same syndicate that developed the Privateer mine. D. S. Tait, of Victoria, is secretary. Excellent results have been obtained and it is planned to commence at once the shipment of high-grade ore to the Tacoma smelter.

▶ The low level at Hedley Mascot has reached the large orebody found last year by diamond drilling from the main level, 500 ft. above. C. W. S. Tremaine, manager, reports that the ore was 25 ft. wide where encountered, and that channel sampling across a width of 15 ft. returned 0.39 oz. gold per ton.

▶ Operations are proceeding steadily at the two new lode producers in the Cariboo—the Cariboo-Hudson, with a 100-ton mill, and Quesnelle Quartz, with a 25-ton plant. The former is situated 20 miles southeast of Wells, and the latter 40 miles north of Quesnel. Arrangements are being made to finance the development of two other promising properties in the district—the Proserpine, which holds 2 miles of ground along the Barkerville gold belt midway between the Cariboo Gold Quartz and the Hudson; and the Snowshoe, in the Keithley Creek section, to the southwest. At both the Cariboo Gold Quartz and Island Mountain mines, Wells, excellent results are being obtained. Production at the former in November had a value of $152,950, and at the latter, $56,119.

MEXICO

Workers Take Over Mine In Guanajuato

Property unable to make profit will be operated by miners' cooperative—Strike at mines of Cia. Real del Monte y Pachuca settled—Property in Guanacevi district Durango rehabilitated

▶ Guanajuato Reduction & Mining Company, Augustus MacDougall, manager, recently transferred its properties to 3,000 workers to run cooperatively. This action ended labor trouble which had lasted three weeks. Workers with a fund of 50,000 pesos donated by miners' and other workers' organizations planned to resume operations late in December. The company was forced to suspend operations in November because of its inability to maintain profitable operations in face of the 12 per cent export tax.

▶ Some Christmas cheer was afforded the Mexican mining industry with the assurance President Lazaro Cardenas gave Ambassador Josephus Daniels that the Mexican Government is not even thinking of mine properties expropriations, and settlement of the strike against the Cia. Real del Monte y Pachuca, operating the world's greatest silver mines at Pachuca, Hidalgo. The strike lasted for 78 hours and involved some 6,500 employees. It was feared that Real del Monte, like several other important mining companies that have had major labor trouble, would be handed over to its workers to run on a cooperative basis. That fate was spared this company. The settlement, representing concessions on both sides, represents a victory for the strikers in that the company's yielding on higher wages and other economic benefits means exalting its yearly overhead by 2,700,000 pesos (about $550,000). The company agreed to pay full wages during the time of the strike as well as costs of the movement. Yet it appears that the company got off rather lightly, for, according to company officials, the workers' demands for higher pay and other concessions would have meant an annual boost of 32,000,000 pesos (some $6,500,000) in overhead. The workers themselves said that their original demands would have entailed a yearly

extra outlay for the company of 14,000,000 pesos ($2,900,000). Work is now reported as normalized at the Real del Monte properties.

▶ Peñoles Mining has shipped 5,000 metric tons of lead to Germany and Czechoslovakia, via Tampico, on a German steamer. This is the largest single lead shipment to Europe in several months.

▶ Granting the workers most of their demands attained labor peace for Cias. Mineras Kildun y Anexas and Santa Maria de la Paz, Villa de la Paz, San Luis Potosi, which allowed daily pay rises averaging 40 centavos (8c.), and El Boleo, a French copper enterprise at Santa Rosalia, Lower California, which canceled its plans to dismiss several employees and lower the pay of those retained and agreed to arrange wage increases on a sliding scale in accordance with copper prices. Cia. Minera de Agujita, Sabinas, Coahuila, also straightened out a labor row by agreeing to arrange for higher wages.

▶ President Lazaro Cardenas has ordered included in the federal mineral reserves all free lands containing gold in Sonora, Nayarit, Sinaloa, Durango, and Lower California.

▶ Organization of a government financial and other aided miners' cooperative society to exploit gold-silver tracts near Oaxaca City, Oaxaca, is being completed by the Ministry of National Economy.

▶ Leases on property in the Guanacevi district, Durango, have been obtained by the Guanacevi Mining, J. W. Swent, general manager, which is arranging considerable exploitation on the new tracts. The company has reconditioned its 100-ton flotation and cyanidation plant.

▶ Reorganization has been started for the Cia. Minera y Exploradora Azteca, S. A., of the General Mines group, Guillermo A. Burr, president, Belmar Hotel, Mazatlan, Sinaloa. The new company's stock will be 1,500,000 pesos (about $320,000) and it is to operate mines that General controlled.

▶ Action has been deferred by the Mexican Government on the petition of 60 miners of the Cia. Minera Doce Apos-Ktoles, S.A., Buenavista, Guerrero, who say that they were dismissed without cause, that the properties be expropriated as a public utility and given to the petitioners to run on a cooperative basis.

▶ A cooperative society of prospectors and small-scale miners of the San Ignacio zone of the rich El Tambor gold fields, Sinaloa, has been organized by the ministry of national economy.

▶ Properties in the San Pedro de Corralitos district, Chihuahua, are being worked by J. H. Blackwell, Arizona mining man, Apartado 142, Ciudad Juarez, Chihuahua. A fair amount of gold-silver-lead ore is being shipped to smelters at El Paso, Tex.

▶ Work is progressing at the Paleros-Miseria properties, Guanacevi sector, Durango, by the Cia. Minera El Palero, S.A., president and general manager of which is Harold M. Cobb, Guanacevi, but operations are hampered by a labor conflict. There are expectations, however, that the issue will be settled soon.

AFRICA

Cam & Motor Encouraged By Deep Ore Find

Development on the 35th level reveals better grade of ore—Bibiana, in the Gold Coast, enlarging mill capacity—Ariston Gold Mines planes extensive underground development

▶ Shareholders of the Cam & Motor Gold Mining Company were told at the annual meeting, by Viscount Elibank, the chairman, that the values encountered from the 33d level downwards to the 35th are appreciably below the average of the ore hitherto being milled. It will be recalled that when the vein was found to average 11.7 dwt. per ton over a width of 65 in. for a length of 1,070 ft. at the 31st level, it was thought that Cam & Motor was to disprove the assumption that all Southern Rhodesia gold mines "petered out" at depth. But though the oreshoot is somewhat longer and only a little narrower on the 32d, 33d and 34th levels the values have dropped to 7.3, 4.8, and 4.6 dwt., respectively. However, on the 35th the first 440 ft. driven has revealed ore averaging 5.9 dwt. per ton over a width of 66 in., and continuing improvement is reported. The zone of lower-grade ore is already exerting an influence to reduce head values and will, it is frankly admitted, cut down both production and earnings while it is being treated. Ore reserves are about five years ahead of the mill, and the hope is entertained that the improvement on the 35th level points to the existence of another zone of richer ore below. Cam & Motor has an excellent record, having already paid nearly £3,500,000 in dividends.

▶ Ashanti Goldfields is apparently acting on the suggestion from its engineer that a higher average grade of ore be sent to the mill, as in November the yield of the 19,544 short tons of ore treated was 21,955 oz. of fine gold. The average hitherto has been an ounce or slightly less. Mine profit in November was £106,490, which, with other income, brought the total profit up to £111,490, against £109,094 in October. Ashanti's position is that of having plenty of high-grade ore to supply its 20,000-tons monthly mill over a long period, and also considerable resources of lower-grade ore. The management has to decide whether it is advisable to treat the richer ore to the capacity of its present mill, or to extend the mill and work the lower-grade ores now instead of leaving them for the future. It is a problem which has often been met and decided by other managements.

▶ Bibiana, another Gold Coast Colony mine, recovered 4,212 oz. of gold from 12,500 tons milled in October, and made a total profit of £11,191, against £9,411 in October. Some stretches of high-grade ore are being met with in this mine, but the company is erecting additional milling capacity.

▶ Ariston Gold Mines (1929), Ltd., has increased its capital from £800,000 to

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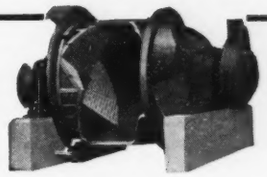

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▶AFRICA

£900,000 and will sell the 800,000 new shares of 2s. 6d. par to shareholders at a price of 7s. each. The chief reason for raising this additional capital is that a scheme has been recommended for the development of three miles of ground along the strike of the formation being worked by the Ariston and Marlu gold mining companies. It seems to be the intention that Ariston, Marlu, and Gold Coast Selection shall participate in the undertaking. Ariston will devote a part of the new funds to the further development and equipment of its mine, current earnings having been drawn on, it is felt, too heavily for some time past for this purpose. The tonnage treated by Ariston has been running between 11,000 and 12,000 per month, and J. A. Agnew says work is rapidly approaching the stage which will permit an output of 20,000 tons a month.

▶ Gold Coast Banket Areas has declared an initial dividend of 5 per cent from the profits of the year to June 30, 1938, and an interim of 3½ per cent on account of the present year. This company, formed in 1933, acquired the Fanti Mines, Effuenta Mines, and five mining concessions from Fanti Consolidated Investment Company. Robert Sweeny, an American, is chairman.

▶ The Moscow Narodny Bank in London is paying the eighth half-yearly instalment of £92,500 on the U.S.S.R. Government notes which were issued to Lena Goldfields.

AUSTRALIA

Drought Holds Back Dredging Operations

Shortage of water in many parts retards gold production—Tronah Finance finds several false bottoms in testing placer deposit

Victoria

▶ The mining industry at Bendigo is proving a substantial aid in maintaining the stability of the district, which is suffering from a severe drought. A total of about 650 men is employed, the fortnightly payroll being about £6,200. Dividends for the year to date total £40,000, the highest for many years. The November production of 4,950 oz. was the highest monthly total for many years.

▶ Shortage of water is still affecting alluvial operations in parts of the country. Victoria Gold Dredging, at Newstead, near Castlemaine, has been forced to curtail operations on this account, but has just completed an emergency water scheme which will enable it to carry on. Yields have been lower lately, owing to the dredge traversing previously worked ground.

▶ Cocks Eldorado Gold Dredging, N.L., Eldorado, has just completed a fortnight's stoppage to install a new bucket band and five new jigs. The old bucket-band, which was manufactured by Commonwealth Steel Company, Newcastle, N. S. W., had been in operation since November, 1930, was of manganese-steel construction, with forged nickel-chrome-molybdenum steel pins, and had completed the digging of close on 4,000,000 cu.yd.

▶ An interesting point disclosed in the recent boring, for Tronoh Finance, Ltd., of the near-by Harrietville alluvial area, was the existence of several false bottoms before bedrock was finally reached. Past dredging operations in this district have been confined to material above the first false bottom, which is at an average depth of 30 ft. There is thus the possibility of the re-dredging of large areas of ground which have been worked previously to shallow depths only.

New South Wales

▶ It was announced at the annual meeting of Broken Hill South, Ltd., that unless orebodies at present unknown are discovered in the course of prospecting and development, the total probable reserve of ore in the property would be about 4,150,000 tons, or enough to maintain operations at the present scale for another eleven years. The orebodies are gradually narrowing in depth, particularly in the northern part of the mine, and it is indicated that not much ore is likely to be found below the 1,630-ft. level. There is, however, always the possibility of the discovery of repetition bodies, and the results of a detailed geological survey, commenced two years ago under the direction of Dr. J. K. Gustafson, an American geologist, but as yet incomplete, will have a large bearing on this.

Western Australia

▶ During the eleven months ended Sept. 30, Big Bell Gold Mines, the low-grade producer on the Murchison field in which Premier Gold has a large interest, treated a total of 294,303 tons of ore for a yield of 52,773 oz. gold, an average of 3.5 dwt. per ton. As the original estimate of ore reserves was for an average value of 3.7 dwt. (or about 3.3 dwt. recoverable), operations to date are encouraging. Dale Pitt is general manager.

▶ Lake View & Star, still Australia's largest gold producer, treated 614,567 short tons of ore and 708,996 tons of old tailings during the year to June 30, for a total yield of approximately 154,000 oz. at the average price for the year. Costs totaled 20s. 10d. stg. per ton, as compared with 21s. 3d. the previous year, reflecting the savings effected by the installation of improved equipment underground, and would have been still lower but for the introduction of the 40-hour week and of higher wage rates which came into force during the year. J. Thorn is general manager.

▶ South Kalgurli Consolidated, Ltd., ore reserves at Sept. 30 totaled 271,000 tons averaging 5.19 dwt. per ton, against 278,000 tons and 5.70 dwt. on March 31. This company is the only one on the field still employing the old dry crushing and all-roasting process originally developed for Kalgurli telluride ore.

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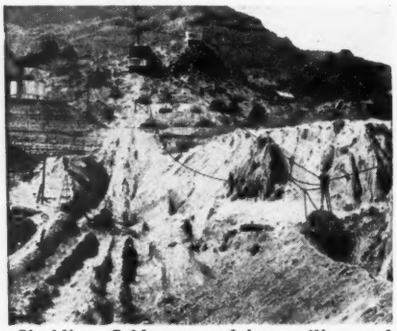
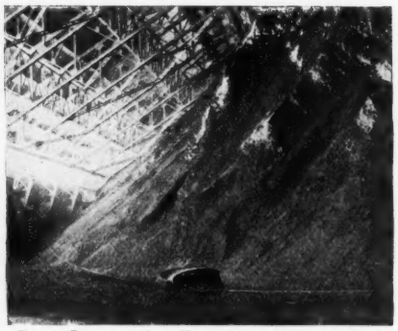
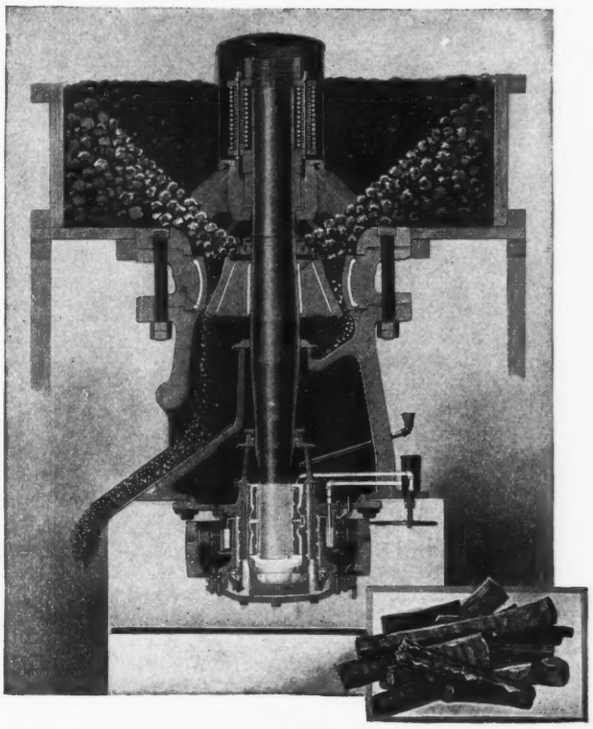


Slackline Cableway reclaims tailing and conveys to bin on hill 1,000 ft. away.



Drag Scrapers handle indoor storage of ore, coke and pitch at aluminum refinery.

Compare the Results . . . . of an actual test



A concern who planned to buy a new crusher decided to run a crushing test to determine the capacity, power consumption, and sizing ability of a KENNEDY BALL BEARING GEARLESS CRUSHER and a competitive make Cone crusher.

•

Here are the results:

No. 37 KENNEDY CRUSHER . . . . 85 tons per hour
Driven by a 50 HP Synchronous Motor

4′ Cone Crusher (Size larger than the KENNEDY) **72** tons per hour
Driven by a 100 HP Motor

Both machines were crushing Dolomite Rock. The KENNEDY was set to 3/16″ and the cone was set to 5/16″.

THIS IS A SAMPLE OF HOW THE KENNEDY CRUSHER WILL INCREASE YOUR CAPACITY AND LOWER YOUR COSTS.

Send for Bulletin No. 35

KENNEDY-VAN SAUN MFG. & ENG. CORP.
2 PARK AVE., NEW YORK, N. Y.

▶AUSTRALIA

▶Golden Horseshoe (New), Ltd., which is at present re-treating the old dumps of the Great Boulder Proprietary Company on a profit-sharing basis, put through 651,080 short tons during the year to Sept. 30, for a yield averaging 4s. 11d. per ton. Working costs totaled 2s. 4d.

Tasmania

▶Net profit of the Mount Lyell Mining & Railway Company, Ltd., for the year to Sept. 30 dropped to £A150,830, or £193,000 less than that of the preceding twelve months. The fall was mainly due to the lower average price of copper. Working costs showed an increase from £A47.603 to £A52.264 per long ton of copper produced. Ore treated rose from 841,427 long tons to 1,032,128 tons, but the average grade fell from 1.75 per cent to 1.48 per cent copper. Production, as copper in blister, was 12,676 tons (12,792 tons in 1937). Production of cathode copper was a few hundred tons more owing to a carryover from the previous year. Ore reserves at Sept. 30 were estimated at 11,146,000 tons assaying 1.52 per cent Cu (content of copper 169,400 tons), compared with 9,894,000 tons at 1.69 per cent Cu (copper content 167,200 tons) a year earlier.

NEW ZEALAND

▶The first of several large gold dredges being erected in New Zealand started early in December, when the Kanieri Gold Dredging Company's plant near Hokitika, on the west coast of the South Island, is scheduled to commence operating trials. The dredge, which was designed in Sydney and fabricated in New Zealand, weighs approximately 3,000 tons and has a designed capacity of 400,000 cu.yd. per month. It is capable of digging to 85 ft. below water level.

FIJI ISLANDS

▶Optimism for the future of gold mines on the Tavua field was expressed by the chairman at the annual meetings of both Emperor and Loloma companies, held in Melbourne recently. It was stated that developed ore at the Emperor gave an assured life of over five years, with a reasonable net profit expectation of £200,000 for that period. The downward continuation of the body is as yet undefined, although winzing has proceeded below 400 ft. Treatment of the sulphide ore will eventually require a change in mill practice, and flotation will probably be adopted following on experiments now in hand. Meanwhile the readily accessible and cheaply mined sulphide ore will provide mill feed for a considerable time. At the Loloma mine, over six years' ore is in sight, and the body at the 224-ft. level, the deepest point yet reached, is more settled, wider, and richer than at the 120-ft. level above. The lode at this level has been found to extend considerably further south than at the 120 ft., and this feature, together with the southerly pitch of the pay-shoots, has made it necessary to sink a new shaft to command these southerly extensions.

WHAT IS *Your* I. Q.*?

How much do you know concerning subjects pertaining to your own industry?

Do You Know—

- The applications of a Mercury Arc Rectifier?
- The names of 10 manufacturers of Ball Mills?
- What company makes Geophysical Equipment for the modern prospector?
- Five prominent manufacturers of Sand Pumps?
- Where to purchase Spiral Drill Steel?
- The haulage capacity of electric mine locomotives equipped with steel-tired wheels?
- The horsepower required to elevate ore?
- The length of a wire rope splice for various size ropes?

Questions like these may come up in your business during 1939. You can get the answers to them — and many others — in the

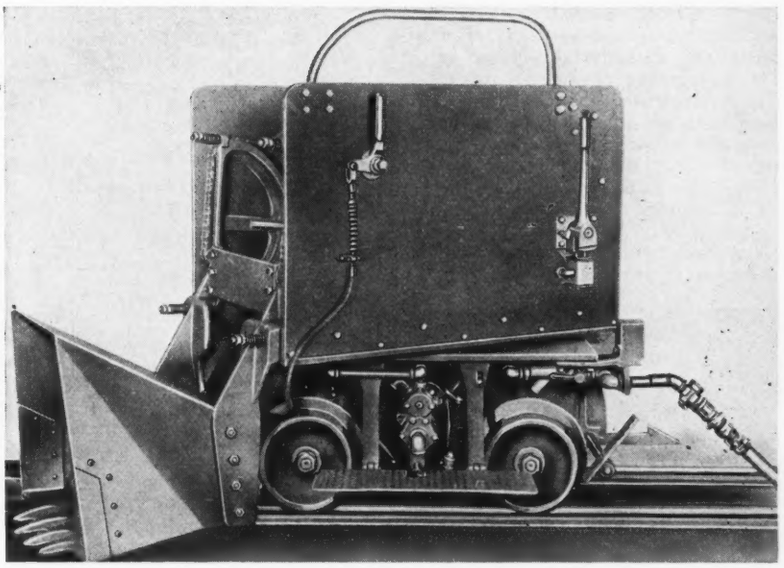
1939 METAL QUARRY CATALOGS

McGraw-Hill Publishing Co., Inc.
CATALOG & DIRECTORY DIVISION
330 West 42nd St., New York, N. Y.

*Intelligence Quotient

EQUIPMENT NEWS

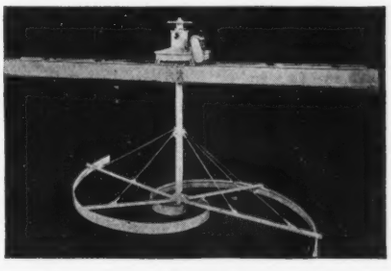
Mine Car Loader



SULLIVAN MACHINERY COMPANY, Claremont, N. H., announces the Sullivan HL-1 mine-car loader for use in narrow headings. Powered by two 9-hp. Pistonair motors, the shovel is said to perform with speed and economy. Features listed by the manufacturer are flexible action of rocker arm, streamline design, little exposed piping, compact and rugged construction, large heavy-duty roller bearing, and heat-treated chrome nickel steel gears. Some of the specifications of the unit are: air consumption-average is 60 cu.ft. per minute while loading; air pressure required in pounds is 50 to 90, and the range of track gage is 18, 20, 22, or 24 in. Over-all width with control levels in position is 32¾ in. and with bucket raised the over-all length is 47½ in. The over-all height with bucket raised is from 78½ to 86½ in., and the discharge height of bucket, 48 to 56 in. A variable leverage device is said to permit three different bucket speeds near the end of the loading cycle. The first speed is for loading cars up to 45 in. long and the two faster bucket speeds are used for longer cars. After bucket is emptied an automatic plunger quickly returns bucket.

Thickener Mechanism

HARDINGE COMPANY, INC., York, Pa., announces the development of a new thickener mechanism known as the "Auto-Raise." Breakage due to overloading, or obstructions falling into the tank, is said to be avoided by this device because the moment the scraper encounters such an obstruction, the resistance is transmitted to the driving mechanism, where a separate sleeve, with slots set at an angle, is located and which drives a yoke attached to the scraper shaft or torque tube. The instant the resistance against the torque tube increases above a predetermined degree, this yoke "walks up a hill" until the resistance is relieved. There it stays until the resistance is removed, and then it backs down to its proper position. Marked features of this mechanism are its simplicity of design, its ability to lift the entire mechanism from the danger zone, and its action, which notifies the operator, at once, of what is taking place in the bottom of the tank.

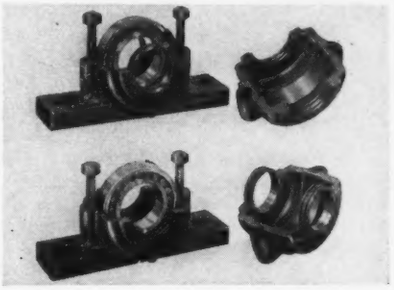


Cushioned Air Cylinders

AIR CYLINDERS with non-adjustable cushion-heads are now available in the same price range as non-cushioned air cylinders, reports the Galland-Henning Manufacturing Company, S. 31st St., Milwaukee, Wis., makers of Nopak two-, three- and four-way operating valves for air, oil, and water. The purpose of this new type cushioned air cylinder was to eliminate noisy, destructive, metal-to-metal impact common to all non-cushioned cylinders. Cylinder life is said to be prolonged by this new built-in air cushion, and more efficient operation and lower maintenance costs for all air powered equipment are also claimed.

Seal for Bearings

A PATENTED TRIPLE SEAL which effectively protects the bearing against lubricant leakage, dust, dirt, and moisture has been made available by SKF Industries, Inc., Front St. and Erie Ave., Philadelphia. This seal consists of two split piston rings on each side



of the housing and grooved on the outside diameter to form a labyrinth seal with the two end bores of the housing. Each ring has an inward tension that enables it to turn with the shaft. On either side of the housing, two rings are mounted on the shaft with the splits 180 deg. apart to prevent lubricant leakage through the splits. The inner ring serves as an internal flinger, and the outer ring keeps dirt and other foreign substance from entering the housing. Because these rings are not securely fastened to the shaft, the seals are free to locate themselves axially whenever shaft expansion occurs. The triple seal is made for the complete range of standard shaft sizes, and is designed for split housings which are machined to allow axial freedom of the bearing.

Diesel Engine-Driven Compressor

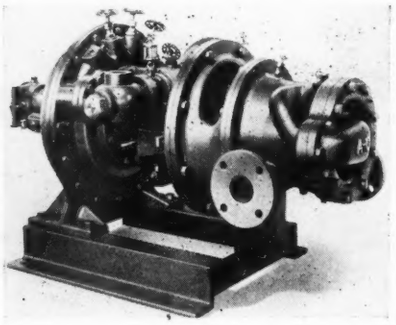
A NEW heavy-duty diesel-engine-driven compressor, known as the "XVO," has been announced by the Ingersoll-Rand Company, Phillipsburg, N. J. This machine is said to be suitable for use wherever economy is a primary consideration, in independent or isolated compressor plants, or when existing power facilities are overloaded. The manufacturer recommends it for use in mines and quarries, construction and contracting, drill barges, air-lift pumping, and general industrial service. The "XVO" is said to be entirely new in design and combines a horizontal heavy-duty double-acting compressor with a heavy-duty "V" type four-cycle diesel engine in a single compact and comparatively light-weight unit which operates at a moderate speed.

Sizes are available for actual-free air delivery ratings of 625, 935, and 1,250 c.f.m. for 100-lb. sea-level compression. In addition, a wide variety of air, gas,

and ammonia compressing cylinders is available for pressures ranging from vacuum to 5,000 lb. per square in. and higher.

Centrifugal Pump

THE CENTRIFUGAL-PUMP division of the Allis-Chalmers Manufacturing Company, Norwood Works, Cincinnati, Ohio, announces a new line of close-coupled



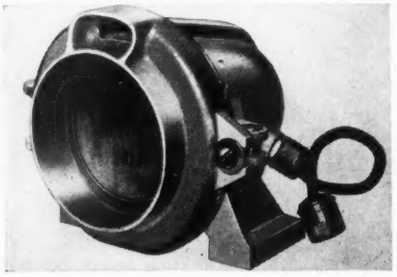
steam turbine centrifugal pumps. The pumps are said to offer advantages of compactness and accessibility, together with operating smoothness and efficiency over a wide range. Units can be obtained in single- and two-stage pumps which are at present available for capacities up to 500 g.p.m. for lower heads and for lower capacities up to 500 ft. In some instances compressed air can be used for driving the turbine.

Testing Electric Blasting Caps

ATLAS POWDER COMPANY, Wilmington, Del., recently announced a galvanometer so designed that it is proof against moisture and water even under the extreme conditions that are sometimes found in large tunnels and shafts. In addition, the new Atlas galvanometer is said to be easy to use; to have a high factor of safety; separate cell compartment; and a light non-corrosive case.

Mine Locomotive Headlight

THE Mosebach Electric & Supply Company, 1153 Arlington Ave., Pittsburgh, Pa., announces a new mine locomotive headlight which is air-cooled for greater efficiency. The air-cooling feature dissipates all heat generated in ordinary

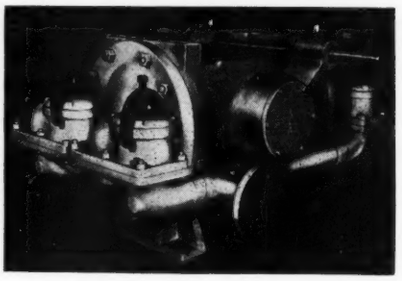


headlights, protecting insulation, wire, and bulb sockets. Cooling air enters through a vent in the top and circulates over and behind the reflector, discharging through the bottom. A 94-watt bulb is used. Bulb socket is insulated in a spring cradle to prevent jarring. The reflector is of bronze, silver plated for stronger and brighter illumination and to eliminate frequent replacement due to damage.

Diaphragm Pump

T. SHRIVER & COMPANY, Harrison, N. J., announce a diaphragm pump for pumping metallic salts, metallurgical, mineral and chemical slimes, slurries and sludges, particularly those fluids which contain a relatively high percentage of quick-settling solids. The unit is especially designed with intake and discharge manifolds at the bottom of the pump, and is of the duplex type. As the material handled is kept from contact with the actuating mechanism by means of two rubber diaphragms, only the liquid ends, valves, valve seats and manifolds need be made of whatever metal or material is best suited to the operating conditions and chemical characteristics of the fluid. The liquid ends and piping can be easily removed for inspection and cleaning. For inspection of the valve chambers only the two yokes and covers in upper half of the chambers need be removed. This is done quickly and easily.

The pump with bottom handling arrangement is available in capacities up



to 100 g.p.m. at pressures up to 100 lb. per square inch and may be built specially for larger capacities up to 250 lb. per square inch. These pumps may be pulley driven, direct motor driven, or arranged for V-belt or variable-speed drive, as desired.

INDUSTRIAL NOTES

The Mine & Smelter Supply Company, Denver, Colo., announces the appointment of W. R. Judson as sole sales representative in the South American countries of Chile, Argentina, Peru, and Bolivia. Mr. Judson will represent the entire line of The Mine and his address is Correo-Clasificador F. 485, Santiago de Chile, South America.

S. I. Bousman was recently appointed chief engineer of the Western Machinery Company's plant at Sacramento, Calif. Paul Ransom, formerly master mechanic of the Mountain Copper Company at its Big Canyon plant, is now in charge of the shop of the Western Machinery Company at Sacramento. Herbert J. Mayer, formerly manager of the Sacramento office of the Western Machinery Company, has been appointed manager of the Los Angeles office, effective as of Dec. 1. He succeeds W. S. Cooper, who remains with the company in another capacity.

The Ohio Brass Company, Mansfield, Ohio, announces that, effective Jan. 3, 1939, its Chicago office, formerly located at 20 North Wacker Drive, will be located at 1580 Continental Illinois Bank Building, 231 South LaSalle St.

J. G. A. Stevenson, formerly of Toronto, has moved to North Bay, Ontario, as manager of Canadian Longyear, Ltd., diamond core drill manufacturers.

Announcement of the opening of a new branch office and warehouse in Seattle has been made by the Macwhyte Company, plant and home offices of which are located in Kenosha, Wis. The new office and warehouse are located at 87 Holgate St.

J. F. Mitchell-Roberts, export manager for Oliver United Filters Inc. (New York, Chicago, and San Francisco), has just returned from a two-year trip which took him around the world. He traveled about 76,000 miles, returning with a comprehensive picture of the industrial situation in foreign countries, particularly the Far East.

BULLETINS

Gravimeter. American Askania Corporation, 826 M. & M. Bldg., Houston, Texas. Leaflet describes the company's mechanical electrical gravimeter.

Wire Rope Electric Hoists. The Yale & Towne Manufacturing Co., Philadelphia, Pa. Catalog W 38 contains descriptive specifications of the manufacturers' Yale Cable King wire-rope hoist, from ¼ ton to 6 ton. Pp. 36.

Portable Electric Tools. Black & Decker Mfg. Co., Towson, Md. This 1939 catalog features the complete line of portable electrical tools and accessories for various industrial uses. Pp. 56.

How to Make Cable Joints. General Electric Co., Schenectady, N. Y. Bulletin GEA 2989 gives detailed instructions for splicing and vulcanizing all the principal types of rubber-insulated rubber-jacketed portable cables. Pp. 16.

Moving Pipe Line. The Johns Conveyor Division of the Osborn Manufacturing Corp., 5401 Hamilton Ave., Cleveland, Ohio. Bulletin describes the uses and operation of the Johns conveyor, which conveys materials and liquids in a moving rubber pipe line of various sizes. Pp. 8.

Truck and Trailer Handbook for 1939. The Four-Wheel Auto Drive Auto Co., Clintonville, Wis. Pocket-sized book contains the road laws and general information governing sizes and weight restrictions of trucks and trailers for all States. Pp. 53.

Repair Clamps. M. B. Skinner Co., South Bend, Ind. Catalog 38A describes and illustrates clamps and saddles for repairing steel and cast-iron pipe. Pp. 32.

Core Drills. E. J. Longyear Co., Minneapolis, Minn. Folder describes and illustrates the manufacturer's various types of diamond drills for use with gas-, electric-, or diesel-driven engines. Pp. 3.

Power Pumps. Worthington Pump & Machinery Corp., Harrison, N. J. Bulletin 423-B-5 describes and illustrates features of vertical Triplex single-acting power pumps. Pp. 4.

Mine Car Loader. Sullivan Machinery Co., Claremont, N. H. Bulletin 76-L describes and illustrates the Sullivan HL-1 mine car loader. Pp. 3.

Metal Cement. Smooth-On Mfg. Co., Jersey City, N. J. Booklet describes applications by working diagrams and explains the steps and advantages of using Smooth-On for stopping fluid and pressure leaks, anchoring in metal, masonry, and wood and filling surface flaws in metal castings. Pp. 39.

Screw Conveyors. Chain Belt Co., Milwaukee, Wis. Catalog 334 describes and illustrates the Rex screw conveyors, screw-conveyor parts and elevator buckets. Pp. 64.

Roller Chains and Sprockets. Chain Belt Co., Milwaukee, Wis. Catalog 333 includes list prices and dimensions of standard and non-standard roller chains and stock and made-to-order sprockets. Engineering information on selecting and application of roller chain drives is given. Pp. 129.

Trommel Screens. Hadfields Ltd., Sheffield, England. Bulletin 416 describes and illustrates the company's types of trommel screens and the Type S heavy-duty vibrating screen. Pp. 11.